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POSTLAUNCH REPORT

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MERCURY-REDSTONE NO. 2

(MR-2)



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Project MERCURY

Space Task Group

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

February 13, 19

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

February 13, 1961

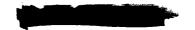


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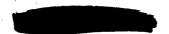


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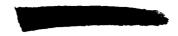


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NOTICE

RANGE ZERO TIME FOR THE MR-2 FLIGHT TEST WAS ESTABLISHED AS 1654:51 ZULU (1154:51 EST). LIFT-OFF TIME WAS 1654:51.82. EXCEPT WHERE NOTED, ALL TIMES REFERRED TO IN THIS REPORT ARE PRESENTED AS ELAPSED TIME IN MINUTES AND SECONDS FROM RANGE ZERO. FOR EXAMPLE, AN ELAPSED TIME OF 2 MINUTES AND 31 SECONDS WILL BE PRESENTED AS 02:31.

1.0 SUMMARY

The MR-2 flight with a primate onboard was made on January 31, 1961. The booster burning rate was greater than normal because of faulty thrust regulation. Propellant depletion was reached 0.5 seconds before velocity cutoff arming and abort system thrust chamber pressure switch disarming. Thereupon the chamber pressure switches initiated a capsule abort at 02:18.

The higher than normal booster thrust combined with the escape motor firing produced greater than normal capsule exit velocity. Exit velocity was 7540 ft/sec as compared to a normal mission velocity of 6465 ft/sec. This greater velocity and the lack of retro firing (retro rockets are jettisoned in this abort mode) resulted in a range of 363 nautical miles, a maximum altitude of 136.2 nautical miles, a period of weightless flight of about 6-1/2 minutes, with a maximum re-entry acceleration of 14.6g.

The majority of the test objectives were met with the following exceptions:

- 1. The landing bag system did not operate properly in two important respects: a. The heat sink struck the bottom of the capsule at impact puncturing two holes in the lower pressure bulkhead. b. The heat sink gradually broke away from the capsule because of fatigue action of the waves after impact allowing the capsule to eventually lay over on its side. As a result of these factors, the capsule took on a large amount of water.
- 2. The snorkel inflow valve opened during ascent at about 18,000 feet so that the cabin did not maintain pressure. With this exception, the environmental control system performed as designed, with the emergency suit system providing a satisfactory environment for the animal occupant. All other capsule systems performed satisfactorily.

The primate occupant of the capsule withstood the flight with no apparent ill effects, continuously performing his given task.

Recovery of the capsule was made 2 hours and 56 minutes after launch and it was returned to Cape Canaveral in the afternoon of the following day.

Post flight inspection revealed the capsule to be in good condition except for the damage caused by the heat sink.

2.0 INTRODUCTION

The Mercury-Redstone Flight 2 was the second of a series utilizing McDonnell-built Mercury capsules and Redstone boosters. These flights are designed to qualify the Mercury capsule for orbital flight and as a flight system for brief manned space flights.

MR-2 had a medium-sized primate aboard. The animal was supplied and handled by the Aeromedical Field Laboratory of the Air Force Missile Development Center, Holloman Air Force Base, New Mexico. Mercury-Redstone booster number 2 and Mercury capsule number 5 comprised the flight system. The test objectives were as follows:

- a. Qualify the environmental control system and seromedical instrumentation.
- b. Qualify the automatic stabilization and control system, and associated components.
- c. Qualify the landing system, with emphasis on the impact bag.
 - d. Partially qualify the voice communications system.
- e. Qualify the mechanical quick opening hatch to be used on the first manned flight.
- f. Obtain a closed loop evaluation of the booster automatic abort sensing system.
- g. Obtain physiological and performance data on a primate in ballistic space flight.

The flight plan was designed to produce a ballistic trajectory having a maximum altitude of about 100 nautical miles and a range of 254 nautical miles. About 5 minutes of weightless flight would thereby result, together with a deceleration of about 11 g on re-entry.



3.1 Capsule

Mercury capsule number 5 with its escape system is shown in figure 3.1-1. The main capsule section contained the pressurized cabin, recovery equipment, beryllium heat sink, and all of the major capsule systems. The conical antenna fairing housed the main biconical antenna system, the drogue parachute, and the horizon scanner system. The escape system consisted of a tower support structure, the capsule escape rocket, the tower jettison rocket, a blast deflector for the conical antenna fairing, ballast, and an aerodynamic spike.

The major capsule systems contained in Mercury capsule no. 5 were as follows:

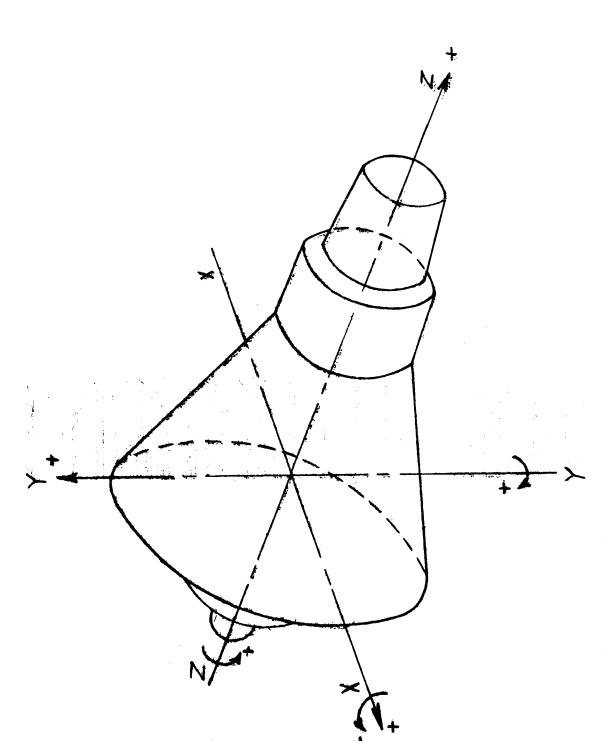
- a. Electrical power and sequential
- b. Instrumentation (Appendix shows measurements made)
- c. Communications. All communications systems were onboard, but there was no provision for exercising the HF voice transmitters. The HF recovery beacon and the HF post descent antenna were not used.
- d. Environmental Control. There was no provision for measuring the high pressure oxygen or the oxygen partial pressure in either the suit circuit or the cabin. Also, the water collecting system was disabled.
 - e. Automatic Stabilization and Control
- f. Reaction Control. Both automatic and manual reaction control systems were onboard.
 - g. Landing and Recovery
 - h. Rockets

A detailed description of the major capsule systems can be found in NASA working paper No. 138.

The following are measured physical data which were obtained during prelaunch preparations of the capsule. Refer to figure 3.1-2 for a definition of the axis system. (Capsule maximum diameter is located at Z station 103.44.)



FIGURE 3.1-1 CAPSULE NO. 5 AND THE ESCAPE SYSTEM



Project Mercury Axis System for Instrumentation, C.G. Locations, and Moments of Inertia Figure 3.1-2

3.0 VEHICLE DESCRIPTION (CONT'D)

- a. Exit configuration (includes capsule, retropack, and escape system).
 - (1) Gross weight

3978.01 lb

(2) CG location

Longitudinal - distance from capsule max. dia.

Z = 66.07 in

Transverse

X = -.23 in

Normal

Y = -.26 in

- b. Re-entry configuration (capsule only)
 - (1) Gross weight

2541.06 lb

(2) CG location

Longitudinal - distance from capsule max, dia,

Z = 19.91 in

Transverse

X = -.16 in

Normal

Y = -.55 in

- c. Flotation configuration
 - (1) Gross weight

2286.18 1b

(2) CG location

Longitudinal - distance from capsule max. dia.

Z = 16.1 in

Transverse

X = -.40 in

Normal

Y = -.43 in

- d. Moments of Inertia of re-entry configuration
 - I (pitch)

519 slug ft²

I (yaw)

532 slug ft²

I₂ (roll)

271 slug ft²



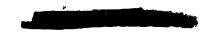
3.0 VEHICLE DESCRIPTION (CONT'D)

3.2 Capsule - Booster Launch Configuration

The Mercury capsule - Redstone booster configuration is shown in figure 3.2-1 at time of launch. No change in configuration as outlined in NASA working paper No. 138 was made. The Automatic Abort Sensing System in the booster was operated closed loop during this flight.



Figure 3.2-1. - MR-2 Booster-Capsule Configuration at Launch



4.0 MISSION RESUME

MR-2 was launched at 1154 hours EST, January 31, 1961. A chimpanzee was onboard.

The launch countdown was accomplished with only minor problems. In total, approximately 4 hours of hold time were required. One result of early holds was a higher than normal rise in inverter temperature which then required further hold time in order to cool this component. The weather conditions were good at the launch site allowing good photographic coverage.

The boosted phase of the flight was abnormal. Because of a faulty thrust regulator in the booster engine, a wide open throttle condition existed, and the engine consumed propellant at a rate that produced greater than normal thrust, and in fact reached propellant depletion 0.5 seconds before the velocity cutoff sensor was armed. Because of propellant depletion the chamber pressure abort switches gave a capsule abort signal. Abort occurred at 02:18.

The relative velocity of the booster at burnout was 7100 ft/sec, rather than the planned 6465 ft/sec. The escape rocket was fired when the abort signal from the booster was received, adding an additional 440 ft/sec for a total exit velocity of 7540 ft/sec.

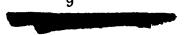
The capsule and tower pitched about 160° during the escape maneuver, at which time the .05g sensor was actuated, switching the ASCS to the re-entry damping mode (at 02:23). This actuation was caused by forces on the capsule.

After tower separation (02:51), the pitch and yaw rates were damped in about 1 minute to zero and a roll rate established at $9.5^{\circ}/\text{sec}$. This value of roll rate is normal for the re-entry damping mode.

The capsule rolled at an attitude of -50° pitch and $+225^{\circ}$ yaw for about 5 minutes.

No commands were given by the ASCS during this time. When the capsule started to re-enter the atmosphere, it was reoriented blunt-face forward by aerodynamic forces. At this time, the ASCS continued to respond properly in the re-entry damping mode. Though the actuation of the .05g sensor had not been envisioned for a late abort, the ASCS performed as designed.

The capsule systems performed satisfactorily during flight except that cabin pressure was not maintained. The inflow snorkel valve inadvertently opened during ascent at about 18,000 feet. The emergency suit system, however, maintained a satisfactory environment for the chimpanzee.



The chimpanzee was disturbed very little by the flight. He tolerated the peak acceleration of 17g during abort, 6-1/2 minutes of weightless flight, and the peak 14.6g reentry acceleration, continuously performing his given task.

Capsule landing was 363 nautical miles downrange, 109 miles further than planned. It had reached an altitude of 136.2 nautical miles, 36.6 higher than planned. The landing at 16:39 followed normal operation of the parachute system.

The first electronic bearing was obtained at 12 minutes and the first sighting after landing was by aircraft at 45 minutes, at which time the capsule appeared upright and normal. By the time the capsule was picked up by helicopter at 2 hours, 56 minutes, it was lying on its side with the cylindrical part of the capsule almost submerged in the water. At pickup, the bag was shredded, the straps were broken and the heat sink was missing. The capsule was delivered to an awaiting LSD where the chimpanzee was removed, alive and well. Approximately 800 pounds of sea water was in the capsule.

Later inspection of the capsule showed that the heat sink had struck the fiberglass protective shield on the bottom of the capsule, which drove two bolt ends through the pressure bulkhead. The larger of the two holes was about 0.16" in diameter. Considerable water undoubtedly entered the capsule through these holes. In addition, water entered through the outlet snorkel and the cabin pressure relief valve once the capsule turned on its side.



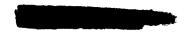
5.0 CAPSULE PREPARATIONS AND LAUNCH OPERATIONS

5.1 Capsule Preparation

Mercury capsule number 5 was delivered to Cape Canaveral, Florida, on October 11, 1960, upon completion of systems tests at the McDonnell Aircraft Corporation and subsequent compatibility tests while mated to the Redstone booster at the Marshall Space Flight Center. The preflight period at Cape Canaveral was divided into systems tests and scheduled rework periods. The total preflight period took 111 days, roughly 50 days of systems tests and pad time and 61 days of rework.

A number of changes were incorporated in capsule number 5 after delivery to Cape Canaveral. The more significant ones are outlined below:

- 1. Heat sinks added to inverters to provide dissipation of the heat generated during long operation.
- 2. Twenty-one thousand foot barostat switches for deploying the drogue parachute rather than the forty-two thousand foot barostats to prevent early initiation of the recovery sequence during a possible tumbling re-entry.
- 3. The main parachute risers were treated with a protective coating to prevent deterioration of load capability in the event that H_0O_0 impinged on them during fuel jettison.
- 4. The 0.05 g inverter bus transfer system was disabled. Capability of switching to the standby inverter in the event of AC power failure was retained. Provision for deactivating the attitude gyros at 0.05 g was not retained.
- 5. A limit switch was installed to provide positive means of periscope motor cutoff after retraction.
- 6. The cabin pressure relief valve was replaced with one that could not open until a head of 0.47 psi was reached. This was done in an attempt to reduce the leakage of water into the cabin from the recovery compartment.
- 7. Provision was made to monitor the temperature of the main 250 VA inverter.
- 8. Provision was made to bypass the 0.2 g sensor as well as the 10 sec timer to provide a means for capsule separation in the abort mode in the event of failure of these sensors.



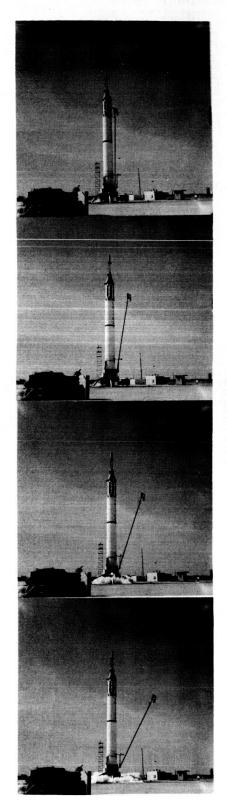
5.1 Capsule Preparation (Cont'd)

9. Rewiring was done to provide for an additional tower separation sensor relay contact to give redundancy to the landing system arming circuit.

5.2 Launch Operations

The launch procedures were arranged in a split-countdown of 250 minutes on one day and 390 minutes on the following day. The operations scheduled during the first portion of the countdown were completed approximately in the allotted time.

Problems encountered during the launch day operations caused the launch to be delayed for three hours and 54 minutes. Minor delays were encountered because of a nonoperative elevator on the gantry, too many nonoperational people on the pad for safe operation, and other incidental items. The ECS preparations required 20 minutes more than was provided for in the final printed This time requirement was anticipated before picking up the count, and the problem was relieved by holding for 20 minutes at -60 minutes. During the latter stages of the count it appeared that the 250 VA inverter temperature, which was steadily rising, might be critically high before launch. -35 minutes when a hold was called to complete required work, it was found necessary to repair a booster tail plug cover flap. It was then decided to open the capsule and cool the inverter. The hold required two hours and 24 minutes. The count was recycled to -120 minutes at the end of the hold. was jumped a total of about 30 minutes by virtue of deleted operations previously accomplished. The launch occurred at 1154 EST. A sequence of photographs showing the launch is presented in Figure 5.2-1.



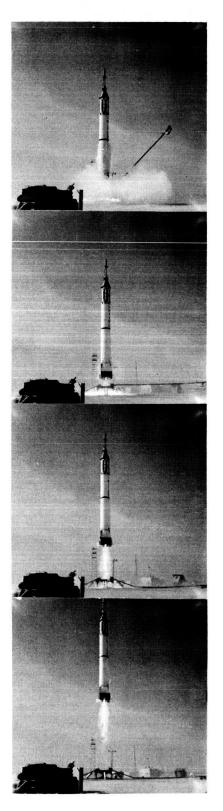


Figure 5.2-1 MR-2 Launch Sequence

5.3 Weather Conditions at Launch

At time of lift-off, the weather was reported as follows:

Planned landing area:

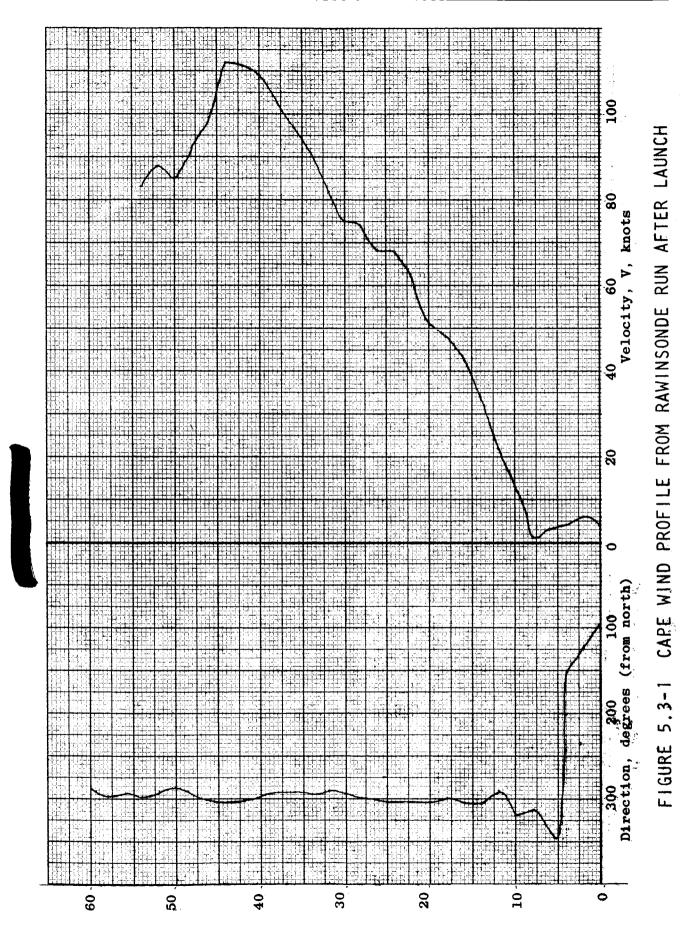
Clouds - .6 coverage Waves - 5 feet Surface winds - 18 knots Visibility - 10 miles

Launch Site

Clouds - .3 coverage Winds - 9 knots from East Sea Level Pressure - 30.31 inches Visibility - 10 miles

These atmospheric conditions permitted good photographic coverage.

A plot of launch site wind directions and velocities near launch time is presented in Figure 5.3-1 for altitudes up to 60,000 feet.



Altitude, h, feet x 10-3

6.0 TRAJECTORY AND BOOSTER PERFORMANCE

6.1 Trajectory

The trajectory data presented in this report are based on the real time output of the Range Safety Impact Predictor (IBM 709 Computer), the quick look AZUSA, and the quick look GBI XN-2 radar data. From lift-off to about 02:13, AZUSA was used in real time. At this time the AXUSA system failed and the input was switched to the Cape FPS-16. Between 02:19 and 02:25 these data were unusable because of excessive noise during the escape maneuvers. At approximately 07:17 the input was switched to XN-2. These data were used until loss of signal near 10:47.

The data presented in this section are based on the following tracking facilities:

	<u>Facility</u>	Range Time, Minutes: Seconds
	AZUSA	00:11 - 02:13
	Cape FPS-16	02:13 - 02:18
		02:26 - 06:40
	XN-2	06:40 - 10:47
7#	NN-2 **	403:40 - 10:47

A comparison of the planned and actual cutoff conditions is shown below:

Quantity	Planned	Actual	Difference
Cutoff Signal	02:23.3	Fuel Depletion 02:18	-00:05.3
Latitude, deg North	28 ⁰ 20,95 ¹	28°20.1'	-00.851
Longitude, deg West	80012,19'	80°11.5'	-00.69'
Altitude, feet	198,967	218,000	20,033
Inertial Velocity ft/sec	7,408	Before After Abort Abort 8,000 8,450	592 1,042
Inertial flight- path angle, deg	40.660	42.27°	1.61°

6.1 Trajectory (Cont'd)

Quantity	Planned	Actual	Difference
Earth-fixed velocity, ft/sec	6,465	Before After 7,100 7,540	635 1,075
Earth-fixed flight-path angle, deg	48.30°	49.54°	1.240°

A comparison of actual and planned trajectory parameters is shown below:

Quantity	Planned	Actual
Range, n.m.	254.1	363
Apogee, n.m.	99.64	136.2
Zero g time, min.	4.89	6.60
Max. booster load factor, g	6.23	6.6
Max, capsule exit load factor, g		17.0
Max. entry load factor, g	10.94	14.6

The ground track of the flight is shown in Figure 6.1-1 and the altitude range profile is shown in Figure 6.1-2. Time histories of pertinent quantities are shown in Figures 6.1.-3 to 6.1-7. In each figure the measured values derived from AZUSA and FPS-16 radar data are compared with the preflight planned trajectory (zero winds) and the postflight calculated trajectory including the effects of the booster engine malfunction, the escape rocket burning, the actual measured wind profile, and retro rockets.

Preflight and postflight data (based on the cutoff conditions) in the terminal region of flight are shown in Figure 6.1-8.

The inertial velocity in the region of fuel depletion and escape rocket firing is shown in Figure 6.1-9. Smoothed Cape FPS-16 data and raw GBI XN-2 data were used to derive velocity. The relatively high points from XN-2 at the time of 02:19 are believed to be erroneous because of the method of data reduction used. The inertial velocity gained from the escape rocket is about 450 ft per sec. This is approximately the value that would be expected for these flight conditions. A discussion of trajectory computing equipment, data from system operation, and plotboard displays are presented in the Appendix.

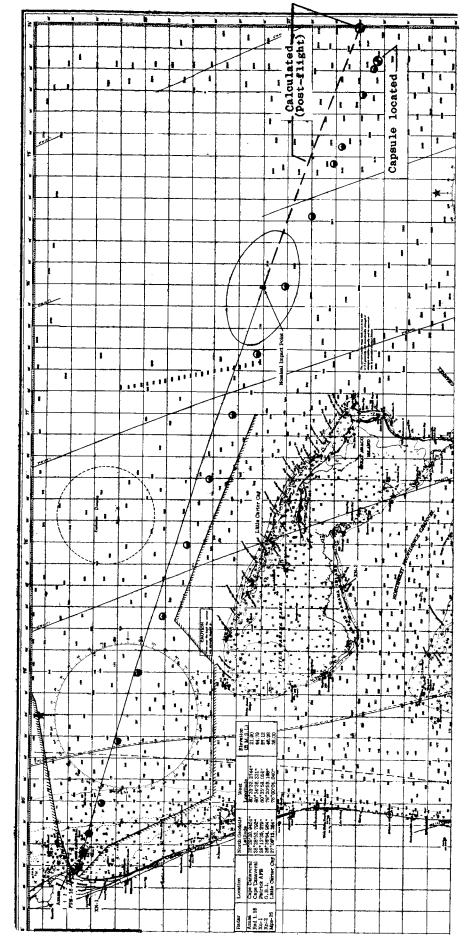


Figure 8.1-1. - Ground track.

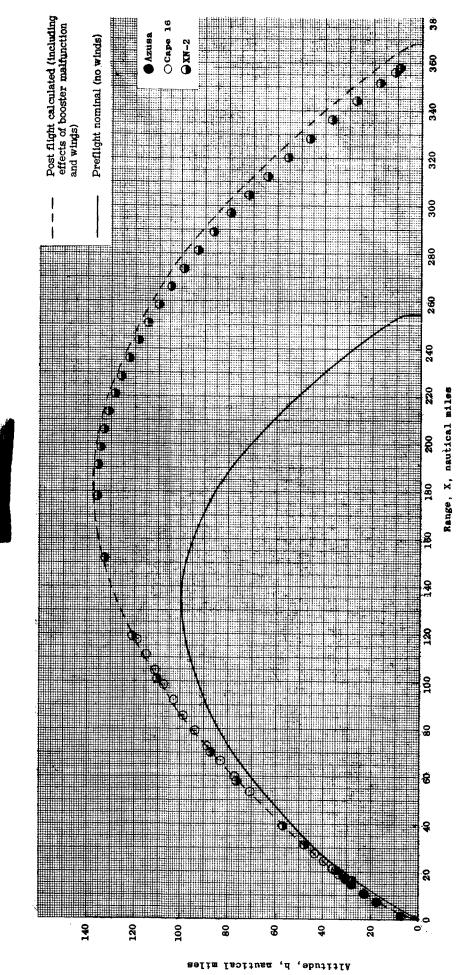


Figure 6.1-2.- Altitude versus range.

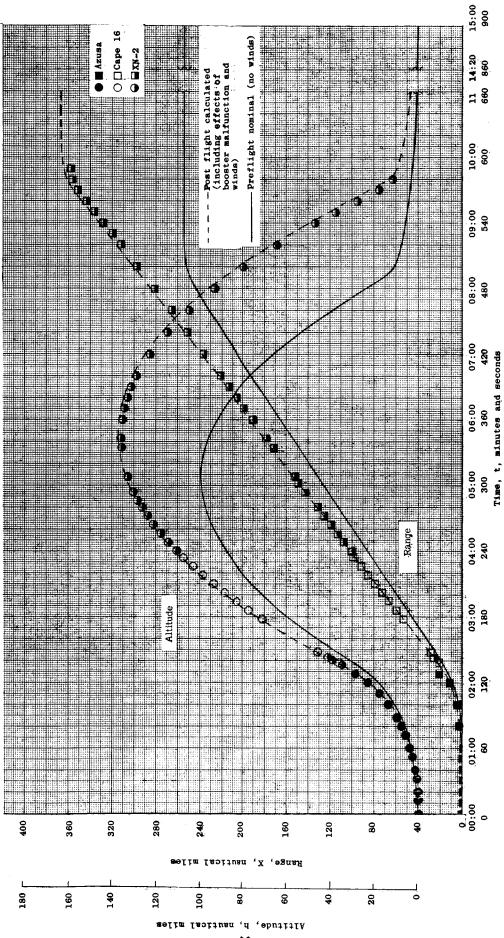
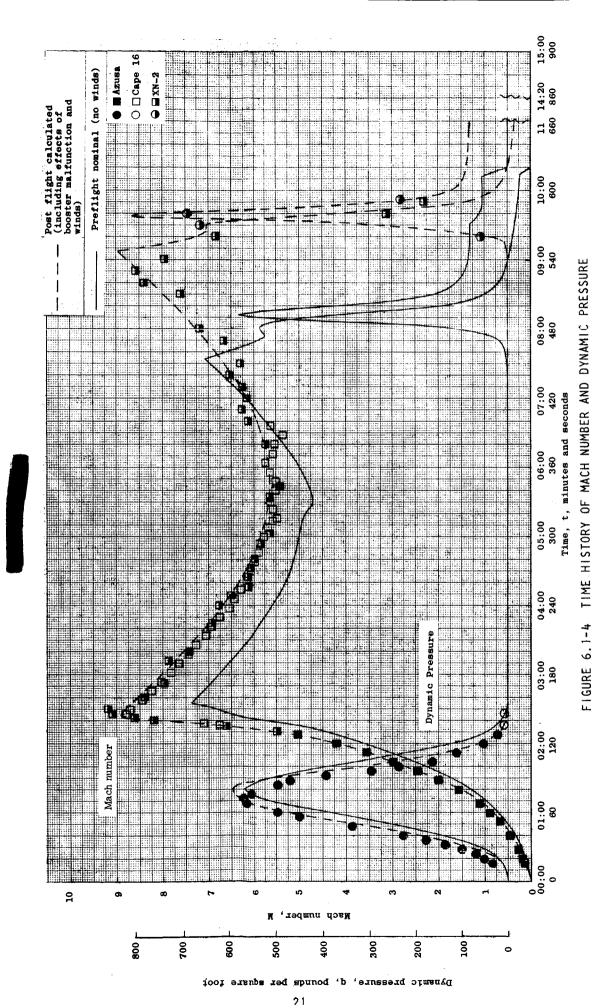
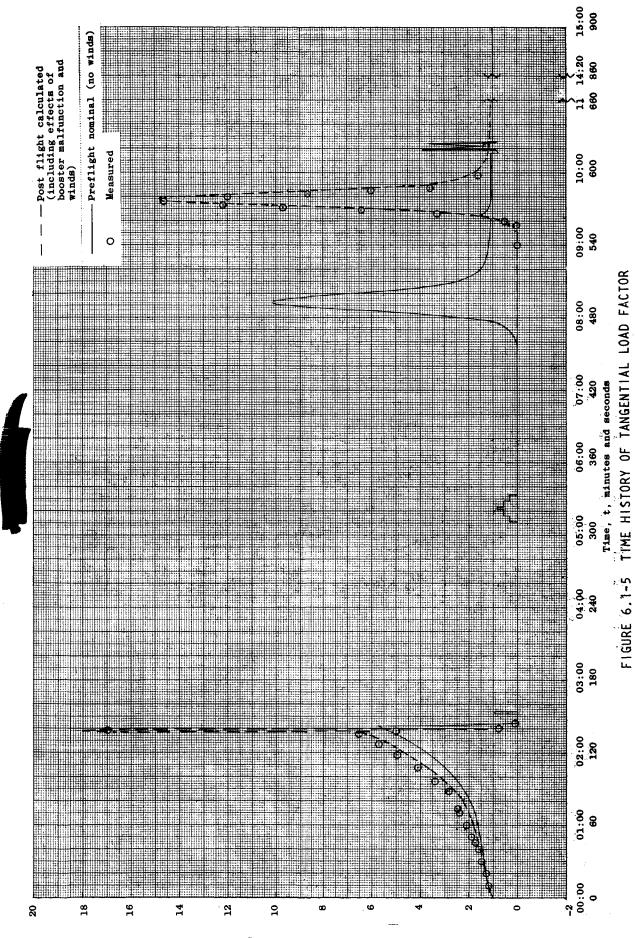


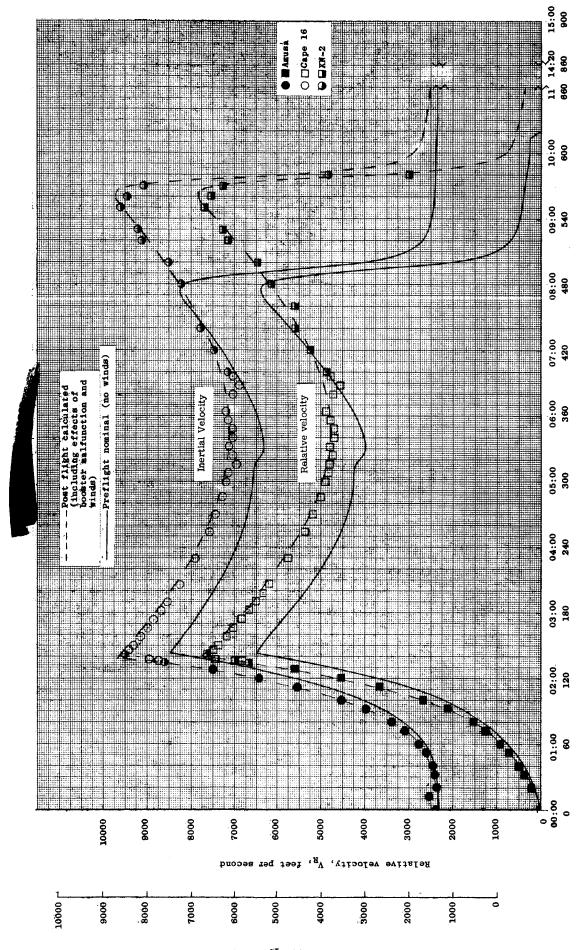
Figure 6,1-3. Time history of altitude and range.

20



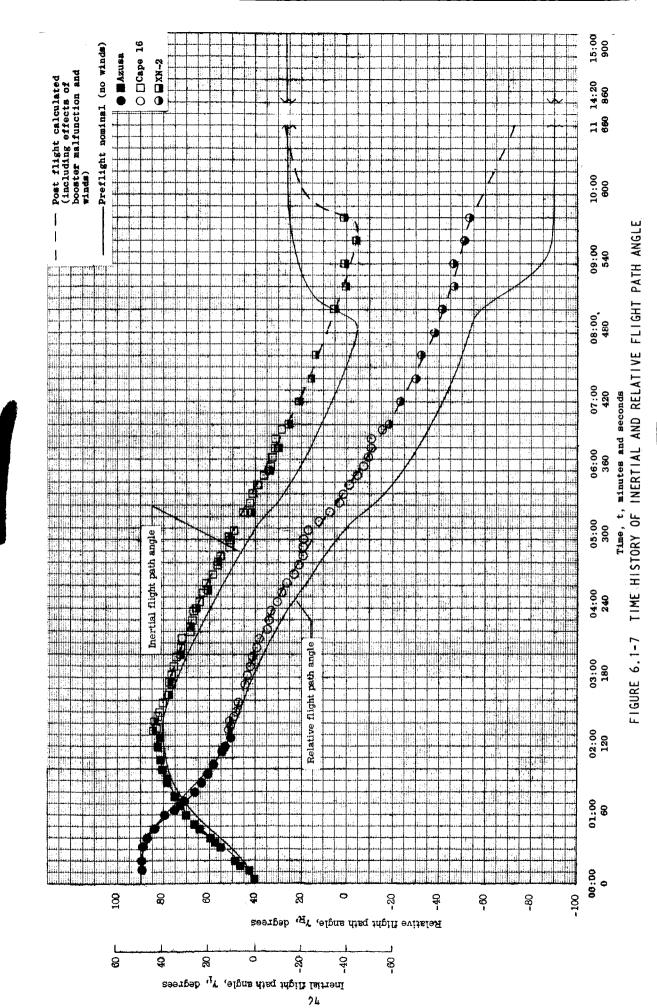


Longitudinal load factor, a $_{T}$, q's



Time, t. minutes and seconds FIGURE 6.1-6 TIME HISTORY OF INERTIAL AND RELATIVE VELOCITY

Instital velocity, $V_{\underline{t},\underline{s}}$ feet per second



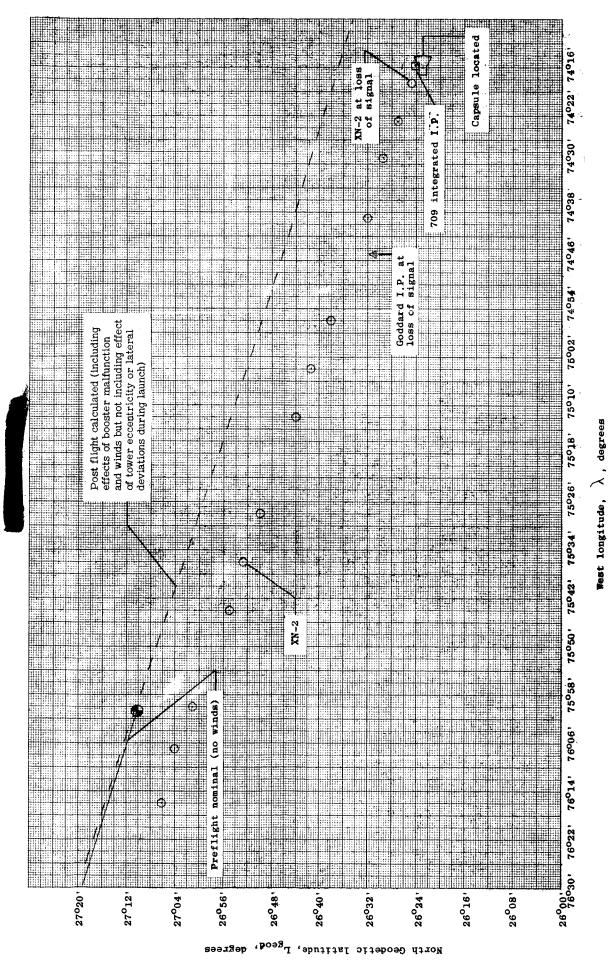


FIGURE 6.1-8 GROUND TRACK NEAR LANDING POINT

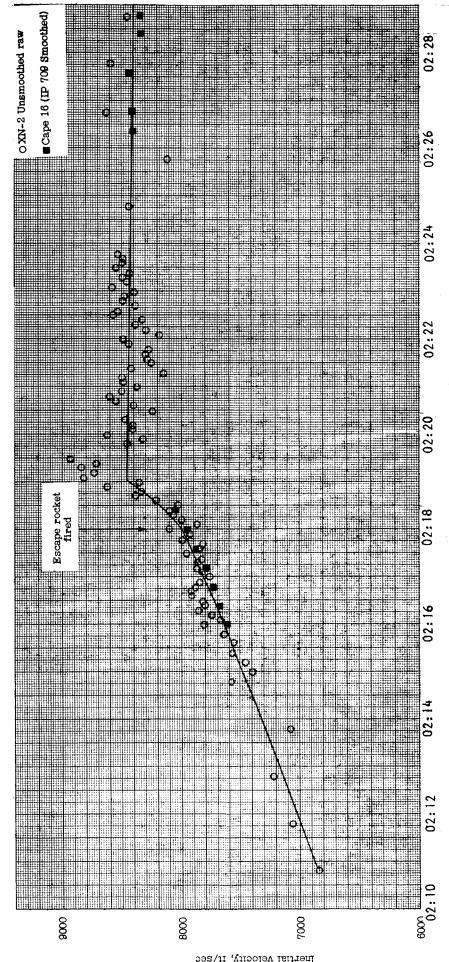
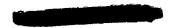


Figure 6.1-9.* Inertial velocity in the region of fuel depletion and tower rocket firing.

Time, t, minutes and seconds

96 Inertial velocity, ft/sec



6.2 Booster Performance

The booster's propellant consumption seriously exceeded the rate planned for in this mission. Consequently, propellant depletion occurred 0.5 seconds prior to the preprogrammed arming of the velocity cutoff function, and 0.5 seconds prior to the disarming of the chamber pressure switch in the abort sensing network. Thus, when propellant depletion occurred, an abort signal was generated and set to the capsule.

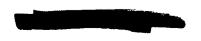
During the flight the thrust chamber pressure reached a maximum of 342 psia, dropping slowly to 334 psia, as compared to 317.5 psia for normal operation. Abnormal operation of the rocket engine was, in turn, caused by abnormal operation of the turbine pump feeding LOX and propellant as a result of two factors:

- 1. There was a malfunction of the thrust regulation system. This caused a wide open hydrogen peroxide flow to the gas generator feeding the steam turbine pump.
- 2. The hydrogen peroxide feed pressure was above normal value. Normally the hydrogen peroxide tank is regulated to a pressure of 590 psig. In this case the pressure exceeded the upper limits of the range of the telemetered signal which cannot indicate pressure above 600 psig.

Booster sequential functions were as shown below:

		Time (Min:Sec)
	Flow rate starts decreasing	02:17.6
2.	First combustion pressure decay	02:17.6
3.	Acceleration drops	02:17.8
4.	Pressure chamber switches 1 and 2	
	closure	02:17.8
5.	Abort bus hot	02:17.8
6.	Electrical separation	02:18
7.	Adapter ring vibration	02:17.9
8.	Abort from capsule	02:18
9.	Integrator cutoff and pressure	
	sensor disarm	02:18.3

The Automatic Abort Sensing System functioned normally. No false signals were generated, but the thrust chamber pressure sensing switches initiated an abort signal when propellant depletion occurred and chamber pressure dropped.



7.0 CAPSULE MEASUREMENTS AND SYSTEMS PERFORMANCE

Capsule systems generally performed satisfactorily throughout the MR-2 flight, with three major exceptions:

- 1. Failure to maintain cabin pressure during flight.
- 2. Failure of the landing bag system to perform satisfactorily.
- 3. Failure of the pressure vessel to remain watertight after landing.

A summary of measurements obtained and general systems performance is presented in the following paragraphs.

7.1 Measurements

7.1.1 Accelerations

The longitudinal acceleration data are presented in Figures 7.1.1-1 and 7.1.1-2 for the exit and re-entry, respectively. The acceleration increased from 1.2 g at lift-off to 6.5 g at 02:17, the time of booster cutoff. At 02:18 the capsule began the abort sequence. Peak acceleration during escape rocket firing was 17.0 g. After escape rocket firing, the acceleration decayed to zero and the period of weightlessness began and continued for about 6-1/2 minutes. First measurable deceleration occurred during re-entry at 09:20, reaching a maximum of 14.6 g at 09:36 and decaying to 1.3 g at loss of telemetry signal (10:20) at Cape Canaveral. Examination of onboard records showed that drogue chute deployment caused a pulse of less than 0.5 g at 10:54 and that a 3 g pulse was experienced at deployment of main chute at 11:28. Throughout the flight, lateral and normal accelerations were small prior to landing.

Landing accelerations as recorded by the three peakreading accelerometers installed in the instrumentation pallet were as follows:

X (lateral)	Y (normal)	Z (longitudinal)
+3.5g -4.7g	+3.4g -16 .8g	+20g or greater* -7g

*Amount over 20g is not accurately known because of instrument limitations.

Both the maximum longitudinal and normal accelerations were roughly twice the values experienced in qualification air drops of the impact bag system in a rough sea condition. It was not possible to determine the sea condition, surface winds, and capsule attitude at impact for the MR-2 flight, but the rate of descent is known to be normal.

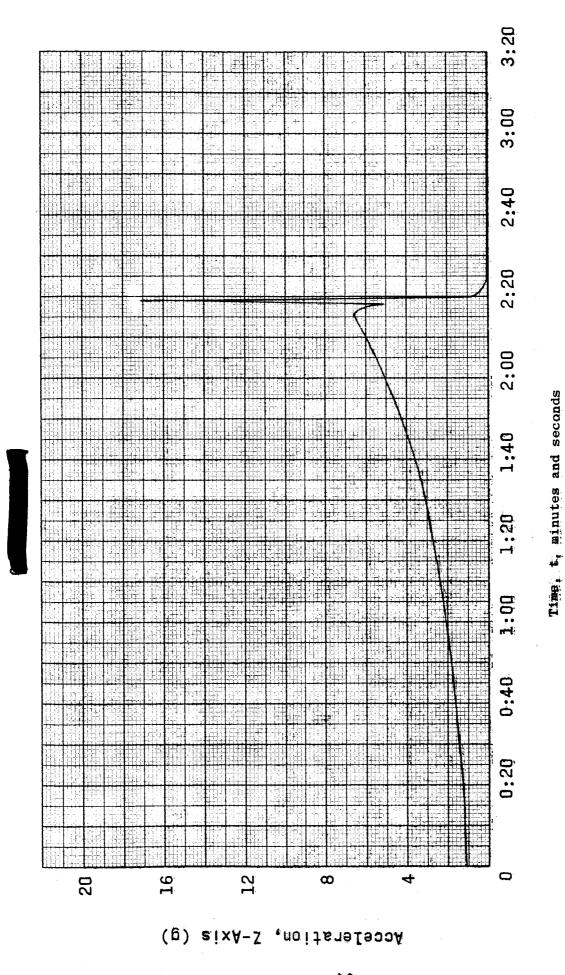


Figure 7.1.1-1. - Longitudinal Acceleration (Exit)

Figure 7.1.1-2. - Longitudinal Acceleration (Re-entry)

Time, t, minutes and seconds

Acceleration, Z-Axis (g)



7.1.2 Temperatures

Thermocouples were installed to measure capsule temperatures as follows:

- 1. Outer skin temperature on the conical afterbody.
- 2. Inner skin temperature on the conical afterbody.
- 3. Heat shield temperature.
- 4. Inverter temperature.

Cabin air and suit inlet temperatures were also measured and are discussed in paragraph 7.4.

Outer skin temperature, Figure 7.1.2-1, rose to a maximum of 310° F during exit. Maximum outer skin temperature during re-entry was 255° F. These temperatures are as would be expected.

Inner skin temperature rose gradually from an initial value of 96° F at lift-off to 120° F at 10:00 and cooled to 114° F at loss of signal (10:20).

Heat sink edge temperature, Figure 7.1.2-1, did not rise appreciably until re-entry, at which time a maximum temperature change of 80°F was measured.

The above temperatures are consistent with the trajectory flown.

The inverter temperature caused considerable concern in the prelaunch phase and is discussed in detail in the Appendix.

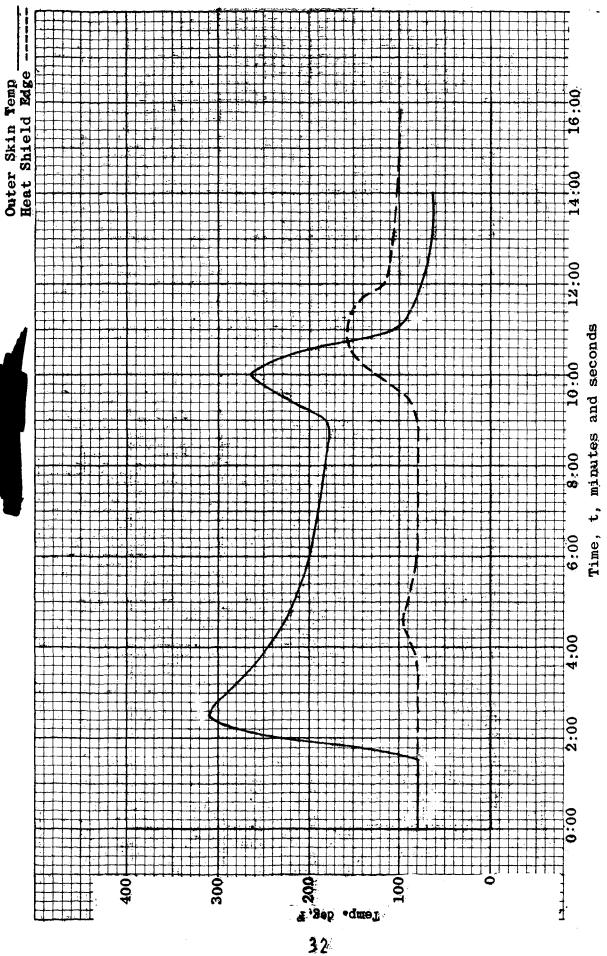


Figure 7.1.2-1. - Variation of Outer Skin and Heat Shield Edge temperature with time.

7.2 Automatic Stabilization and Control System (ASCS)

At the time of capsule separation 02:18, the capsule (with the escape tower attached) rotated about all three axes. The motions in pitch, yaw and roll continued after tower separation, and at 03:54 the capsule became attitude stabilized in pitch (-50°) and yaw (225°) with a steady roll rate of 9.5°/sec. The exact motions of the capsule during the period from 02:18 to 03:54 are as yet unknown because the rolling motions of the capsule made the attitude measurements unreliable. The pitch and yaw motions were imparted to the capsule by escape rocket firing. The roll rate of the capsule resulted because the .05g relay closed and placed the ASCS in the damping and constant roll rate mode normally called for during reentry. The closure of the .05g relay resulted from either one or all of the following:

- (a) Drag resulting from a combination of 3.5 psi dynamic pressure and the heat sink forward orientation of the capsule at this time.
 - (b) Tail-off of the escape rocket firing.
- (c) Centrifugal forces resulting from capsule rotation.

From 03:54 until 08:55, the capsule attitude remained approximately constant in pitch and yaw with a steady roll rate of 9.50/sec. This roll rate is very close to the design requirement of 100/sec to 120/sec. There were no pulses from the RCS during this time interval. The measurements obtained from the attitude gyros during this time interval were sinusoidal in all three axes and the amplitude and periods were constant. See Figure 7.2-1. It appears that the ASCS damped the pitch and yaw rates to zero at about 03.54 and that no rates in pitch and yaw in excess of the boundaries required to initiate ASCS action were experienced during this five minute period.

At 08:55 the capsule began to respond to re-entry aerodynamic distrubances and the ASCS showed the proper response to these disturbances. Also, at this time, the capsule began to turn around, and re-entered the atmosphere with the heat shield pointed in the direction of flight.

From data obtained, it appears that the automatic stabilization and control system functioned as designed for this mode of operation.



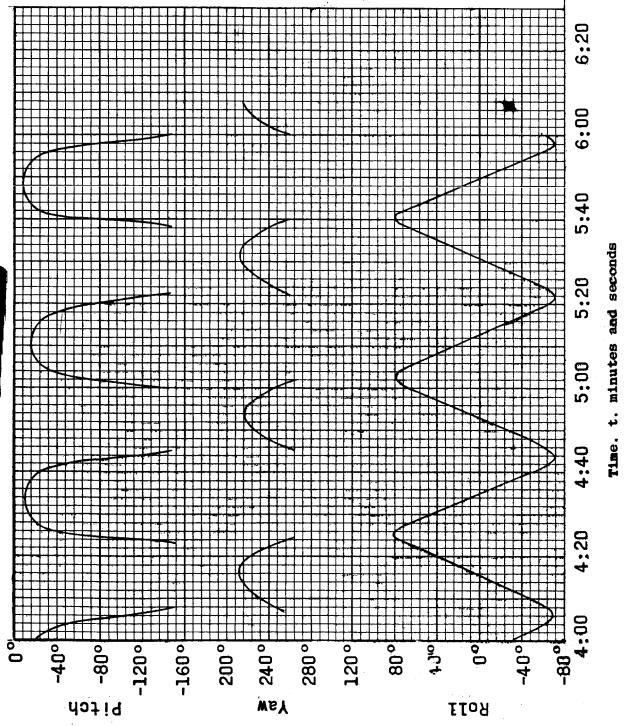


Figure 7.2-1. - Gyro attitudes during weightless period.



7.3 Reaction Control System (RCS)

The RCS functioned satisfactorily throughout the mission. Between 0.05 g relay actuation and tower separation, the automatic system expended approximately 13 pounds of hydrogen peroxide. An analysis of the resulting reaction of the capsule to this expenditure of fuel indicated that a specific impulse of 120 sec was achieved. This value appears to be satisfactory. The system was not called upon to operate for approximately five minutes after tower separation. During re-entry approximately 14 pounds of hydrogen peroxide were expended, and the fuel was exhausted at nearly the same time as drogue chute deployment. The pulse duration was so short during re-entry that it was impossible to determine an Isp. The manual system was emptied 45 seconds after the signal was given to jettison fuel. The variation of fuel consumption with flight time is presented in Figure 7.3-1.

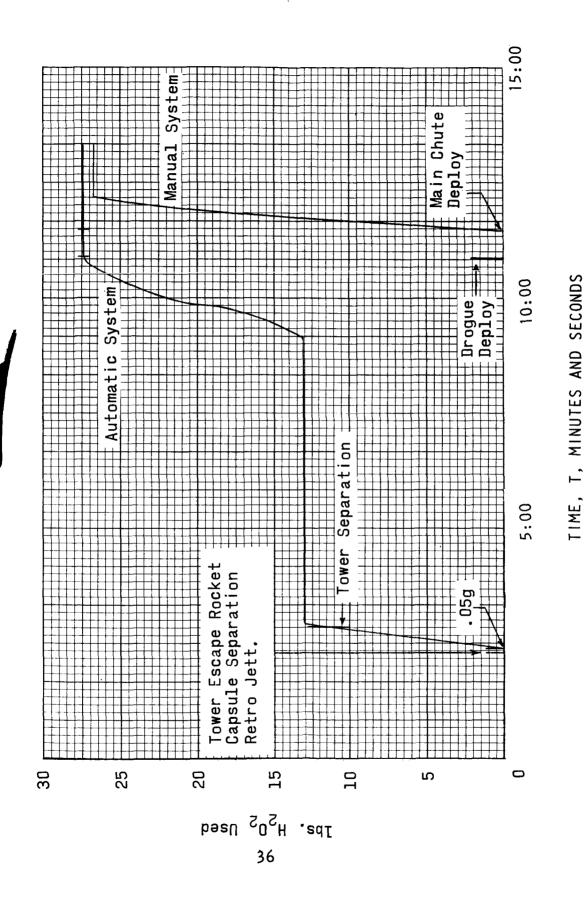


Figure 7.3-1.- Reaction Control System Fuel Consumption

7.4 Environmental Control System

Although the cabin failed to maintain pressure during the flight, the emergency suit system operated as designed and provided a satisfactory environment for the animal occupant, Figure 7.4-1. The following sequence of events has been established as a result of analyses of the available data:

- (a) During ascent, at 00:57, the inflow snorkel valve opened, placing the suit circuit in the postlanding mode, and causing the cabin pressure to decay to a value slightly above ambient through the negative pressure relief valve and then through the open inlet snorkel. This condition occurred at approximately 18,000 feet.
- (b) The suit circuit maintained approximately design conditions for the duration of the flight.
- (c) The cabin pressure increased during descent, at first through the cabin relief valve and then through the outflow snorkel valve when this opened at 20,000 feet. It is believed that the inlet snorkel valve was operated either by vibration or by premature squib firing. At actuation of this valve, three events properly occurred:
- 1. The emergency mode was initiated. On-board film substantiates this.
- 2. The cabin fan was turned off as evidenced by a reduction in DC current at this time.
 - 3. The suit fan kept operating.

The suit maintained pressure because of the check valve in the inlet snorkel valve line provided for this purpose. The suit circuit was regulated to 5.5 psia, which is above specification. The pressure transducer was indicating 0.4 psi above normal at launch and therefore the regulator was probably operating above tolerance.

The cabin pressure relief valve appears to have operated as designed. Postflight tests in the altitude chamber showed it to be in normal working condition.

Onboard film records were used for this analysis, because there are self-contained, direct-reading, pressure gauges on the instrument panel. Telemetry records of pressure are somewhat confusing because during descent, they show that the cabin pressure

7.4 Environmental Control System (Cont'd)

was about 1 psia above ambient. These data are obtained from transducers with a range of 0-25 psia and with an accuracy of about $+\ 1$ psia.

After the failure of the inflow valve, the ECS operated as designed. Suit and cabin temperatures ranged from 58° and 102°F at launch, to 66° and 109°F at landing, respectively. The cabin temperature reached a maximum of 115°F at eight minutes after launch.

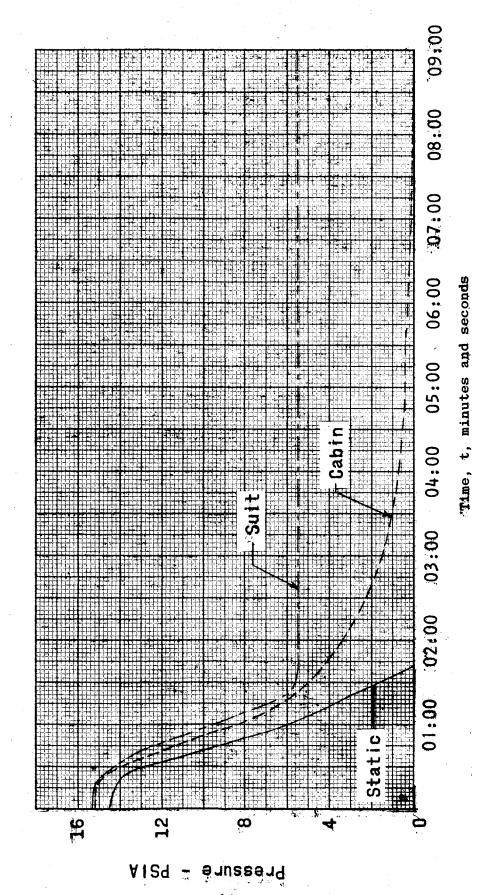


Figure 7.4-1. - Variation of suit, cabin, and static pressures with time from launch.

7.5 Electrical and Sequential

All data indicates that the capsule electrical and sequential systems performed as expected for an abort maneuver. The time of major events was as shown below:

Lift-off - 1154:51.82 EST

Range zero - 1154:51 EST

SEQUENCE OF EVENTS

EVENT	PREDICTED TIME	ACTUAL TIME
	FROM RANGE ZERO	FROM RANGE ZERO
Mayday		02:18.0
Tower escape rocket	02:23.32	02:18.0
Capsule separation	02:23.32	02:18.0
Retropack jettison	06:11.82	02:18.8
.05g signal	07:41.22	02:23. 0
Tower jettison	02.23.32	02:50.7
Time of retrofire signal	04:41.82	04:52.6
Drogue deploy	09:33.82	10.54.3
Main chute deploy	10:13.12	11.28.0
Loss of signal		16:39.0
(probable impact)		

At 00:57, the DC current started to decrease from a value of 28.6 amps, and reached a low value of 25.3 amps. This value was maintained until the beginning of the escape maneuver. This reduction is compatible with the change in mode of the ECS.

Time histories of DC current, DC voltage, and AC voltage are presented in Figure 7.5-1.

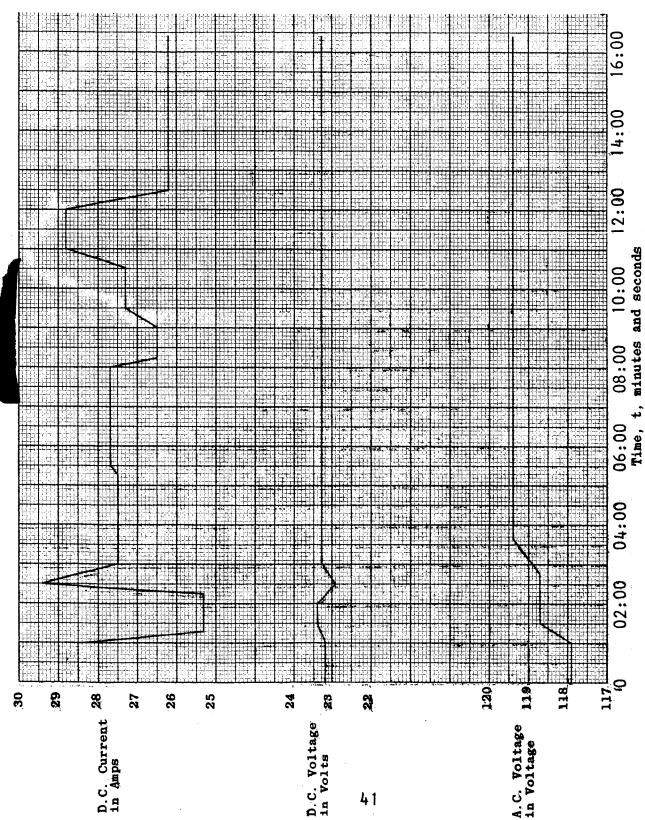


Figure 7.5-1. - Time Histories of DC Current, DC Voltage, and AC Voltage



7.6 Communications and Tracking Systems

The data reviewed for the MR-2 mission did not reveal any major imcompatibilities between vehicle and ground range equipment or major problem areas requiring corrective action.

The playback of the UHF voice, as recorded at the Grand Bahama Island Station and in the capsule, indicated that the voice communication was fair for the ranges involved. See Figure 7.6-1. For UHF reception in the Mercury Control Center see Section 9.3.

The tracking data from the Atlantic Missile Range radar sites (ten C and S band radar stations) located at Cape Canaveral, Florida; Patrick Air Force Base, Florida; Grand Bahama Island, and San Salvador, indicated continuous tracking throughout the trajectory from launch to main parachute deployment (Figure 7.6-2). In most cases the radars acquired the target at low elevation angles and lost track at 0° elevation. In general, the C and S band beacons and ground radars performed as intended.

Retrocommand was transmitted at 04:41. However, because of the abort on this mission and a consequent retrojettison, confirmation by telemetry was not possible.

Telemetry transmission was considered good throughout the mission except for occasional dropouts which affected real-time displays at the Mercury Control Center.

The UHF recovery beacon performed well, as recovery aircraft indicated that beacon signals were received up to one hundred and thirty nautical miles after main parachute deployment (time of beacon activation).

UHF voice T/R CW mode was considered to perform well. Recovery aircraft reported receiving signals at a 50 mile range. This mode is actuated at an altitude of 10,000 feet.

L					
		TIME ACQUIRED	time Iost	SIGNAL QUALITY	REMARKS
	UHF Voice GBI	02:09	10:31	Fair	
	Capsule On- board tape	-27:00	Last ground transmission received aprx 09:39. Cap. transmissions recorded until	Good at short range. Only fair after 05:00 aprx 16:00.	Considerable distortion as range increased. The CW transmissions from Tel III were loud and clear out to 08:00
	Tel III (UHF	Voice) Tape	not available	for evaluation at th	this time
	Command receiver	Rec	Receipt of command	command could not be confirmed	pe
43	UHF Recovery Beacon	At deployment of main chute (10,000 ft)	See remarks	Good	Signals received at 130 n.m, by recovery aircraft, lost for a short time after the capsule was in the water (beyond liner of-sight). Signals acquired again at about 50 n.m.
لبيبينا	CW Mode UHF Voice T/R	After impact	See remarks	Good	This mode is activated at 10,000 ft. Signals picked up at 50 n.m.

FIGURE 7.6-1 COMMUNICATIONS AND TRACKING SYSTEMS PERFORMANCE

	L	1	A 200 L 100 A							
			g			Track lost)st	Time (T-0)	1-0)	
Radar site Loca- Rnge AZ tion n.m.			ı	园,	Rnge n.m.	AZ	· 털	Acquired	Lost	Remarks
Mod II, 1.3 Cape 3.3 175°	i i	i i		001	346	109	80	90:00	09132	Acquired on Auto Skin at 25 sec. Switched to Auto Bea, at 55 sec. Lost Auto Bea, momentarily then reacquired before end of track.
MOD II, 1.5 Cape 5.3 1780		1780	1: 1	9 0	355	109°	00	-00:07	09:24	Acquired on Auto beacon at T-O, 20 db attenuation at launch. Removed attenuation at 660 K yd.
Cape Pad	Pad				355	108.80	%	40	98160	Auto skin at T-0. At läunch power attenuated to 10 percent. Auto Bea. at 00:30. Skin track at T-0 unusable due clutter.
Patrick Pad 6.2 1.	Pad 6.2		-i	1.20	354	1060	00	-00:17	98:60	Strong beacon returns: Auto beacon track at 19 seconds:
GBI 159 313° 2.	3130		8	2.20	222	9 <u>t</u> 0	ò.;	01:27	10;24	Bea, frequency shifting mode track- ing difficult.
GBI 161 · 313.5° 1.5°	. 313.50	_	٠ ٦	٠٥,	221	926	°r	01109	10:04	Beacon lobing throughout.
GBI 159 515° 2.2°	5130		2	0	217	91.20	.30	01:39	10;24	Beacon frequency shifting 15 MC
San 395 Salwador	86				136	; ;		02:24	13:25	Apparently lost track at 1705;40 and reacquired at 1706;12.5 and continued to 1708;16, Beacon returns were strong
San 357 Salvador	1	1990		-	139			04:13	12:09	
Salvador 357			i		139		,	03:42	#:11	Bea. Sig. weak during last 10 sec of track.
							,			

* Deta not complete.

Note: Data not available from Bermuda, Grand Turk or from radar sites aboard Picket Ship.

FIGURE 7.6-2 C AND S BAND RADAR TRACKING SUMMARY

7.7 Instrumentation

In general, capsule instrumentation performed very satisfactorily throughout the flight. Photographic data from the three onboard cameras were adequate for engineering evaluation, and the tape from the onboard recorder was of good quality.

The instrumentation consisted of the following:

- 1. Telemetry
 - (a) Commutated channels
 - (b) Continuous channels (biomedical)
- 2. Cameras
 - (a) Instrument panel (16 mm)
 - (b) Primate observer (16 mm)
 - (c) Earth and Sky (70 mm)
- 3. Onboard tape recorder
- 4. Peak-reading impact accelerometers
- 7.7.1 Telemetry system performance
- 1. Commutated channels all commutated channels operated properly throughout the flight, with the following exceptions:
- (a) Commutator A, segment 20, outer skin temperature transducer and Commutator B, segment 19, heat shield temperature transducer.
- (b) Commutator A and B, time-since-launch segments, interim clock. The time-from-launch counter stopped during periods of high acceleration and appeared to be running fast during flight. This same result occurred on the MR-1A flight and was expected on this flight. The quality of the transmitted signals was excellent during periods of usable strength. The system noise was less than two percent and the decommutated data were acceptable.
- 2. Continuous channels all three continuous channels performed satisfactorily. These channels transmitted biomedical information, consisting of EKG and respiration rate and depth measurements.

7.7.2 Cameras

- 1. Instrument panel camera Operation of this camera was excellent during flight. This camera was partially emersed in water during the recovery period. Salt water penetrated the covers and caused some dark lines along the edge of the film. The pictures obtained were satisfactory and acceptable prints of the film have been made.
- 2. Primate observer camera Operation of this camera was satisfactory. Pictures of the animal were obtained throughout the flight. The mirror normally viewed by this camera to add time correlation was obscured by the couch, making time correlation difficult.
- 3. Earth and Sky camera The pictures obtained from this camera during flight were excellent. Superanscochrome color film was used.

7.7.3 Onboard tape recorder

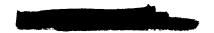
This recorder operated continuously throughout the flight and all tracks recorded. When the recorder was removed from the capsule after recovery, salt water was still draining from the case, indicating an inadequate water seal. The tape was washed in fresh water, dried, and tape copies were made. The data appeared to be of excellent quality.

7.7.4 Peak-reading accelerometers

Since the standard Mercury instrumentation could not measure landing acceleration, three peak-reading acceler-ometers of +20 g range were added. Data were good, although they cannot be time-correlated.

7.7.5 Instrumentation preparation

Several modifications of equipment were necessary to make the system flightworthy. These modifications are discussed in the Appendix.



7.8 Mechanical Systems

7.8.1 Pyrotechnics

All pyrotechnics fired with no apparent misfires. However, the capsule lower umbilical disconnect did not separate (see Section 11.1). As discussed in Section 7.4, premature squib firing could have caused the inlet snorkel valve to open prematurely.

7.8.2 Parachute System

Telemetry records indicate that the drogue and main parachutes opened at design altitudes producing expected decelerations. The capsule rate of descent while on the main parachute near landing impact was 28 ft/sec. All jettisoning devices worked properly.

7.8.3 Landing Bag

The landing bag struck the bottom of the capsule at impact puncturing two small holes in the lower pressure bulk-head (see Section 11.0). It is believed that at some time after impact, wave action fatigued the straps, breaking them from the capsule and allowing the heat shield to sink. The reduced water stability of the capsule without the heat sink caused it to eventually lay over on its side in a near horizontal position. Water may then have entered the capsule through the outlet snorkel and cabin pressure relief valves. The capsule took on a considerable amount of water. In fact, as reported later in Section 10, it was near submersion at the time of recovery.

7.8.4 Quick-opening Hatch

The mechanical type quick-opening hatch apparently performed satisfactorily and no problems were indicated.

8.0 AEROMEDICAL REPORT

8.1 Preflight Operations

In accordance with the objectives of the animal test program (NASA-STG working paper No. 158), the MR-2 vehicle had a chimpanzee occupant to provide animal verification of the success with which the Mercury system could be applied Chimpanzee number 65, figure 8.1-1, was in manned flight. selected by the Air Force Missile Development Center's Aeromedical Field Laboratory group as the primary flight subject on the basis of a complete physical examination and his psychomotor performance record. He weighed 37-1/2 lbs, was 3 years 8 months old, and had no serious illness in the past six months. His general condition prior to flight was excellent. was 120 per minute, respiration 26 per minute, blood pressure approximately 130/105 mm Hg. Sensor installation and suiting started at -9 hours, 24 minutes on launch day. By -6 hours 54 minutes, the animal was installed in the couch. hours 54 minutes the couch was placed in the capsule, and the animal's condition monitored by hard line for five hours during a number of holds until just before lift-off.

Throughout this period his pulse rate remained constant at approximately 120 per minute. Respiration stayed constant at approximately 30 per minute and body temperature stabilized at 99°F. The animal appeared relaxed and showed resting values significantly less than those obtained during control normal work periods measured four days previously.

8.2 Flight

Throughout the entire flight period the animal was submitted to two simultaneous tasks upon right and left hand levers on a panel in front of him. A red light above the right lever signalled the requirement to depress it at least once every 20 seconds to avoid a slight shock. Normally, the animal depresses the lever approximately 60 times a minute. He maintained this rate throughout the boost and zero gravity phases of the flight. During the re-entry and parachute descent the rate fell but did not disappear. A blue light above the left lever signalled that a shock would be given in five seconds unless it was depressed. He performed this reaction test faultlessly responding rapidly and effectively throughout the flight.

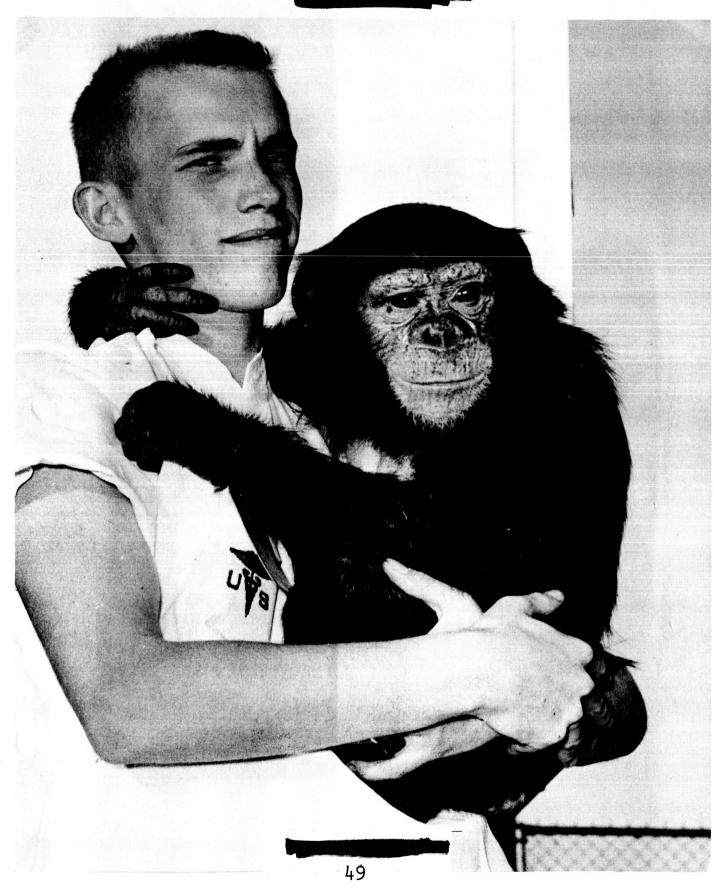
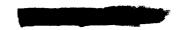


FIGURE 8.1-1 CHIMPANZEE BEFORE FLIGHT



8.0 AEROMEDICAL REPORT (CONT'D)

8.2 Flight (Cont'd)

Figures 8.2-1 through 8.2-6 are 30 second segments that have been extracted from the continuous records taken during a control period, at maximum thrust, immediately after abort, after several minutes of zero g, during max re-entry g, and during parachute descent, respectively.

During the first two minutes and twenty seconds, while the gloadings increased, pulse and respiration also increased, peaking at the 17 g escape motor thrust. During the subsequent six and one-half minutes of weightlessness, pulse and respiration decreased steadily by approximately 20 points returning towards prelaunch resting levels, while the lever response rate appears from preliminary approximate checks to have been maintained unchanged. The animal was disturbed by the onset of the re-entry acceleration, capsule oscillations, and the deployment of the main chute. During the two minutes that these events took place, pulse and respiration rates rose significantly, i.e., from 100 to 160 per minute and 35 to 65 per minute, respectively. During the subsequent five minute period of 1 g descent on the parachute, the pulse and respiration rate declined somewhat.

Body temperature did not change significantly and couch pressure was maintained despite loss of cabin pressure.

FIGURE 8.2-1 AEROMEDICAL FUNCTIONS-PRELAUNCH PHASE CONFIDENTIAL

D1:30 01:45 RESPIRATION RATE AND DEPTH	V. W. W. W. B. S. P. W.	REFERENCE TRACE	Country of district reports. In page 1, in	6.15 4.10 +20	96 100 100 100 100 100 100 100 100 100 10	30 - 20 - 3
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FIGURE 8.2-2 AEROMEDICAL FUNCTIONS-HIGH G BOOST PHASE CONFIDENTIAL

LC COL CLICATION OF THE PROPERTY OF THE PROPER
--

108:45 108:45	96 - 8007 TEMPERATURE 104 - 0 PS A CABIN PRESSURE 109 - 20 - 20 - 20 - 20 - 20 - 20 - 20 -
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FIGURE 8.2-4 AERONEDICAL FUNCTIONS-AFTER APPROXIMATELY 6# MALAULES OF ZERO GRAVITY 54 CONFIDENTIAL

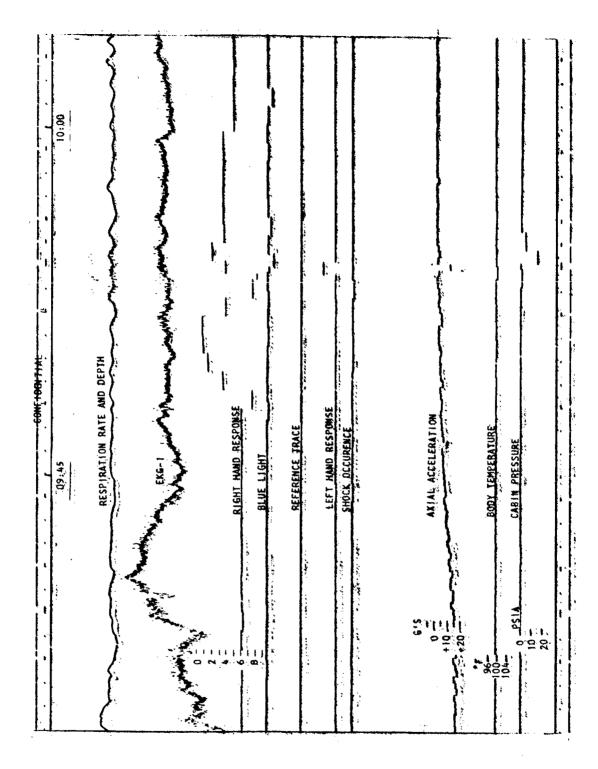


FIGURE 8,2-5 AEROMEDICAL FUNCTIONS-HIGH RE-ENTRY G FORCE 55 CONFIDENTHAL

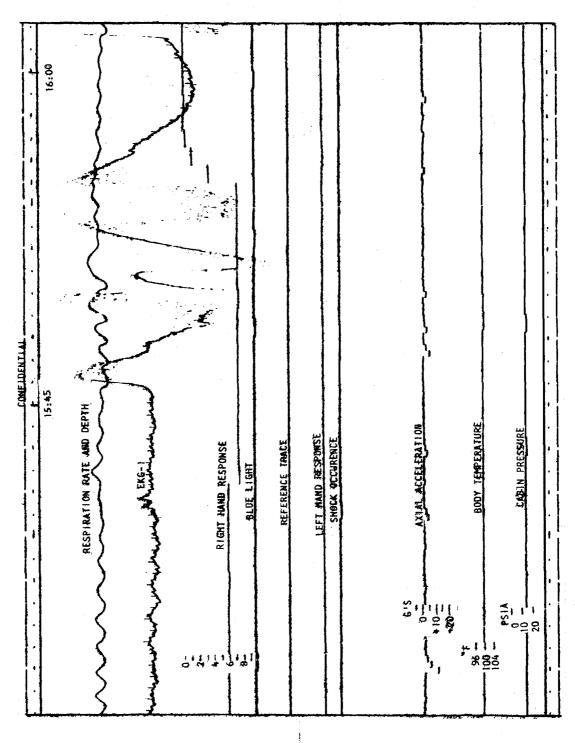


FIGURE 8.2-6 AEROMEDICAL FUNCTIONS-APPROXIMATELY 4 MINUTES AFTER MAIN CHUTE DEPLOYMENT

56 CONFIDENTIAL



8.3 Recovery

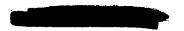
After recovery the hatch was removed and the couch viewed. Condensed moisture on the inside of the couch lid precluded clear vision of the animal, but movement was detected and he was heard making vocal sounds. It is believed that the fans were still running. At 3 hours and 50 minutes the ECS hoses to the couch were disconnected and fresh air under pressure was introduced through the ECS inlet. The near hand hold cover of the couch was removed at 3 hours, 55 minutes. The animal was taken from the couch to the ship's sick bay where a physical examination was performed (Figure 8.3-1). Respiration was 32 per minute and blood pressure, 130/90 mm Hg as recorded before the flight. The hair coat, eyes and ears, skin and mucous membrane were normal. Stethoscopic examination of the heart and lungs revealed no abnormal sounds and the torso and extremities were palpated and no fractures or obvious injuries were found. drugs or other therapy were deemed necessary and none were administered.

Examination of the couch on the DONNER following pickup showed one to two teaspoonfuls of very recently deposited mucous or vomitus which was flecked with blood. It is believed that the animal struggled and swallowed air while on his side in the water and that he belched up a small amount when the capsule was righted during the helicopter flight. The blood flecks appear to have derived from a small self-inflicted abrasion on the bridge of the nose. This finding is considered a post-flight occurrence and irrelevant to the flight itself.

At 0830 EST on the following day, another physical examination of the animal was performed at the Downrange Land-based Medical Facility on Grand Bahama Island. The results of this more complete examination were the same as those obtained on the DONNER. In addition, a chest x-ray was taken. It showed no abnormalities. At 1300 EST, the animal was transferred by aircraft to the compound at Hangar S where on February 2, he was further checked and found to be normal and fit for work on his couch.



FIGURE 8.3-1 CHIMPANZEE AFTER FLIGHT 58



8.4 Equipment Performance

The couch functioned very satisfactorily and on recovery was found to be in perfect working order, including the psychomotor apparatus. The electrocardiograph sensors performed satisfactorily though there was the expected marked shift of baseline during violent movement. The respiratory sensor was very effective and the rectal thermister performed well. All telemetry channels operated satisfactorily with the exception that EKG No. 2 continued to give the same low signal that had been observed prior to launch. The couch environmental control system was very satisfactory in spite of the malfunction of the cabin pressurization system. The animal instrumentation and behavioral test apparatus worked well.

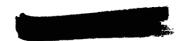
8.5 Primate Performance

Quantitative data indicate that the animal was not disturbed by the six and one-half minutes of weightless flight to which he was subjected. He tolerated the acceleration of escape motor firing at the end of booster burning and re-entry deceleration, continuously performing his given task.

9.0 FLIGHT CONTROL AND MERCURY CONTROL CENTER PERFORMANCE

9.1 Flight Control

The Mercury Control Center (MCC) adequately supported the flight control function for the MR-2 mission, however, with respect to implications or the performance of these functions for an orbital mission a number of problems were evident. These problems were associated both with equipment design and operational procedures. In addition to the information given in this section, additional details are presented in Section 14.



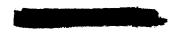
9.2 Telemeter Reception and Real Time Displays

All telemetry equipment functioned correctly with the following exceptions. At 00:12 the MCC TLM 18 lost track and both capsule telemetry links and booster telemetry dropped to less than 1 microvolt for about 0.6 seconds. The Telemetry Supervisor immediately switched to TEL-2 data, but was unable to avoid a miscount on the decommutator which caused all the control relays on the Mission Event Sequence Panel (MESP) to latch up. The panel was reset and correct indication obtained. Two further miscounts were obtained, at 02:19 and 02:35, with the same result as above.

The problem of an erroneous display resulting from a miscount on the decom was known before this mission, and steps have been taken to incorporate an automatic signal level sensing device to eliminate a miscount from giving an incorrect indication on the MESP, and to the Goddard computers. At 02:18 the source of data was switched from TEL-2 to GBI until 03:13, returned to MCC data source at 03:13 until 07:23, then to GBI until loss of signal at 10:23, in order to display the best signal available. The heart rate and respiration rate derived from telemetered EKG and respiration gave erroneous readings throughout the flight. However, this information was derived with some time delay from the strip charts and audio signal. This problem is being investigated and steps will be taken to improve this display.

9.3 Communications

Intercommunications within the control center, and all communications with the blockhouse, the medical facilities at the Cape, GBI, and the Goddard facilities were excellent during the mission. During the countdown, a line to Goddard became noisy which necessitated switching to an alternate link. Communication between the MCC and Recovery Task Force was good at all times. During the post recovery phase a lack of adequate updating information existed between the MCC and personnel in the recovery area.



9.3 Communications (Cont'd)

UHF reception at TEL-2 was good throughout the mission and was used for the Air to Ground voice link by the MCC. A problem with UHF reception by the MCC TLM-18 antenna was detected prior to liftoff. A readable signal could be obtained by slewing the TLM-18 antenna to give off-axis signal reception. Because of the narrow beamwidth, such action was limited since it deteriorated the telemetry reception. This resulted in the UHF communication received by the MCC TLM-18 being unreadable until 01:30. After this time, UHF reception was good until loss of signal. The signal at GBI was unreadable at all times during the flight except for a 20-second period between 02:30 and 02:50.

9.4 Computer Operation and Trajectory Displays

Launch computing subsystem checkout on X-1 day and on launch day prior to T-0 indicated correct functioning of all equipment. During these tests both computers at Goddard were utilized, with frequent switching of data output from "A" to "B" computer. At all times the transition was smooth and satisfactory. During launch all computing equipment and displays functioned satisfactorily. Both computers at Goddard were in operation. The need to switch output did not arise, therefore the "A" computer was used throughout the mission. The loss of AZUSA data and subsequent switching to Cape FPS-16 just prior to abort gave erratic displays at this time. problem is being investigated in order to obtain a smooth transition when data sources are switched. Changes in the computer program will be made in an attempt to minimize the need for manual override signals to the computer. Because of the exceptional overspeed conditions attained, the maximum scaling factors in the computer program were exceeded. These had been provided to correspond with maximum plotboard traverse. A computer program change will be made to insure digital trajectory displays on the Flight Dynamics Officer's console are not limited by plotboard traverse capability. Change of plotboard scale will also be considered as a possible solution.

9.5 Mercury Network Participation

Advantage was taken of the opportunity provided by the MR-2 flight to exercise, in a passive manner, the facilities of the Bermuda Station, the station at Grand Turk, and one of the ship stations berthed in Jacksonville harbor.



9.5 Mercury Network Participation (Cont'd)

Bermuda acquisition aid locked on automatically, enabling telemetry, S-band and C-band radar data, and UHF voice to be recorded. Figure 9.5-1 shows azimuth, slant range and elevation angle of the trajectory from Bermuda. Times of acquisition are indicated on the figure. This is beyond the expected performance of these systems. The data received was considered good for this range. The ship in Jacksonville also acquired automatically; telemetry and UHF voice was received. Data was received by the Grand Turk Station, the quality of which is unknown at this time. These events are considered encouraging, and suggest that the problem of acuisition by Bermuda, so essential in an Atlas mission, may not prove to be as formidable as had been originally conceived.

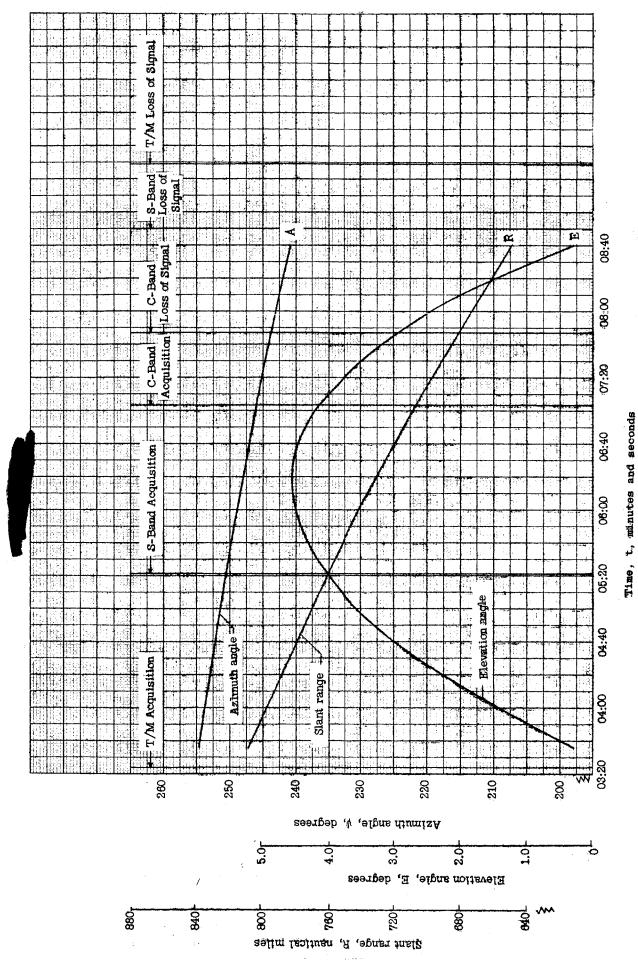
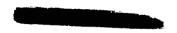


Figure 9.5-1. - MR-2 Radar anglæs as seen from Bermuda FPS-16,



10.0 RECOVERY

10.1 Recovery Plan

Recovery forces were prepositioned in the planned landing areas as shown in Figure 10.1-1. The five airborne aircraft on Stations 1 through Station 5 provided the primary capability for locating the capsule through the use of electronic direction finding equipment. In the primary and secondary landing areas, the destroyers in positions DD1 through DD6, and helicopters from the LSD had the capability of retrieving the capsule. In the event of a landing in the launch site recovery area, helicopters operating from Cape Canaveral provided the primary means of capsule retrieval. Three land convoys provided a backup in the event of a land landing in the Cape Canaveral area. The LARC vehicle in each land convoy had amphibious and rough terrain maneuvering capability to retrieve the capsule. ARS vessel and two T-boats provided a backup in the event of a water landing and had the capability of retrieving the capsule from the offshore portion of the launch site landing area.

The Recovery Task Force Commander was located in the Mercury Control Center and the primary means of communicating with the recovery forces was by voice radio. The downrange Recovery Area Commander was on board the destroyer in Station 5. The launch site Recovery Area Commander was located in a helicopter airborne in the vicinity of Cape Canaveral.

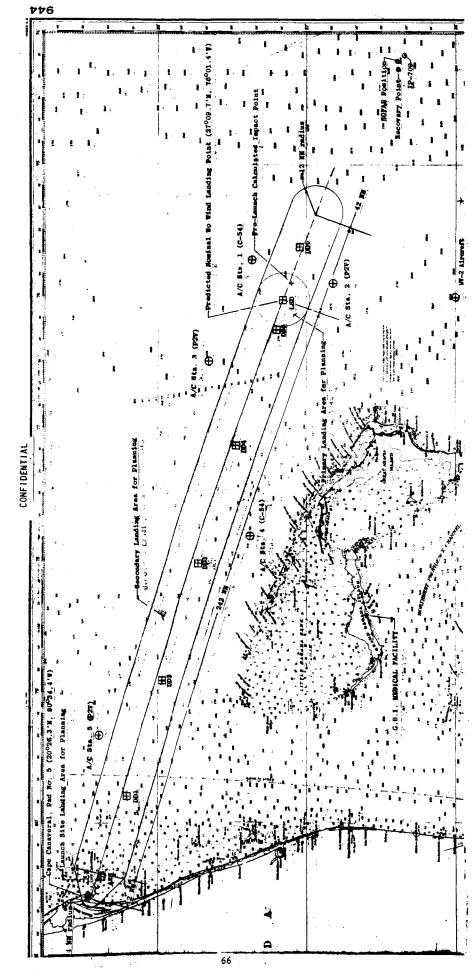


FIGURE 10.1-1 CHART OF RECOVERY OPERATIONS

CONFIDENTIAL

10.2 Recovery Operations

At the time of launch the predicted landing point based upon wind information taken at approximately -6 hours was about eight miles downrange of the nominal no wind landing position (see Figure 10.1-1). The three downrange ships adjusted their prelaunch position about six miles to the east to account for the predicted wind effects. Launch site recovery forces were positioned to cover the predicted landing corridor (based on measured winds) which started about 2,600 feet southwest of the launch pad and passed across the beach to seaward about 3,500 feet south of the launch pad.

Adequate countdown information was received by the downrange recovery forces and they were able to adjust to all holds in a satisfactory manner. At 3 minutes the recovery forces were informed of the time of lift-off and at 11 minutes they were alerted to a possible overflight of the planned landing At 17 minutes the initial calculated landing position and search area was established at 26°21'N, 74°10'W based on IP-709 computer results. At approximately 12 minutes downrange aircraft received UHF-DF signals from the recovery beacon apparently while the capsule was descending on the main parachute. After holding the signal for from two to three minutes and obtaining good identification and bearings, the signal was lost by all aircraft. This loss of signal could have been caused by any one or all of the following factors: descending below line of sight, change in signal characteristics as capsule approached water, or loss in transmission immediately after landing when, based on results from previous landing dynamics tests it can be expected that the top of the capsule will be temporarily immersed under water. With the help of the established search area, the aircraft were quickly able to orient their search downrange, re-establish UHF-DF contact, and home in on the capsule. The aircraft from Station 3 reported visual sighting and on top at 44 minutes. Other aircraft arrived on the scene shortly thereafter. Destroyers from Stations 5 and 6 and the LSD proceeded toward the landing position at best speed. Visual surveillance of the capsule while retrieval forces were on the way indicated the following conditions:

Time From Launch

45 min to 1 hour, 26 min 1 hour 26 min 1 hour 51 min

2 hours 6 min

Flotation Attitude

Upright and normal
Appeared to be listing
List rangle estimated at 40°
from vertical
List angle estimated at 80°
from vertical

10.2 Recovery Operations (Cont'd)

A photograph of the capsule taken from an aircraft during the first time period is shown as Figure 10.2-1, and during the last time period as Figure 10.2-2.

Helicopters were launched to arrive at the landing position as early as practicable, ships continued to close at maximum speed and the first unit on scene was directed to retrieve. At 2 hours 56 minutes, the capsule was retrieved from the water by helicopter and placed on the LSD at 3 hours 47 minutes (Figure 10.2-3).



Figure 10.2-1. - Capsule - Soon after landing.



Figure 10.2-2.- Capsule shortly before pick-up.

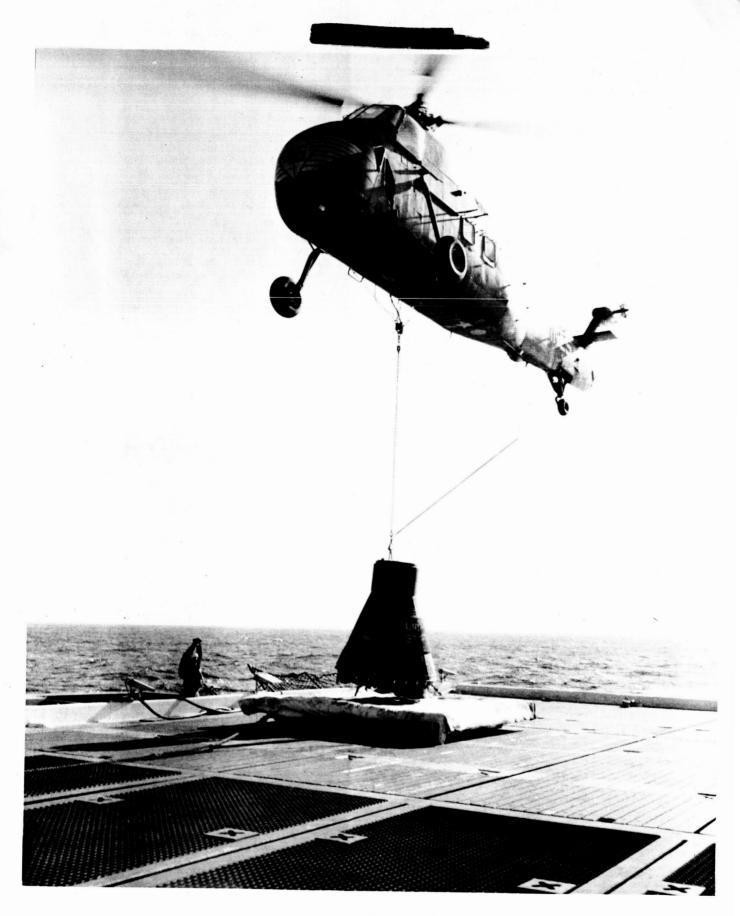


Figure 10.2-3. - Capsule being placed on LSD, Donner.



10.2.1 Retrieval Observations

The helicopters and also the destroyer arriving on scene observed the list angle to have increased to about 90° shortly before pickup was made. The open end of the cylindrical part of the capsule was mostly submerged with the top of the unsubmerged portion an estimated 5 to 8 inches out of the water. Upon arrival on the capsule scene the destroyer measured the following conditions:

Wave height Wind

3 to 4 feet 20 knots (and diminishing)

Upon pickup by the helicopter, observers aboard the destroyer (which was 150 yards away) reported that the heat shield was missing. The pickup helicopter pilot reported that what he thought to be a large portion of the landing skirt was torn so that it was hanging down and that this large piece tore completely away shortly after liftoff.

The helicopter pilot had to dip his recovery hook beneath the water surface to engage the nylon lifting loop, however, hookup was made within two minutes. The helicopter pilot reported that nothing unusual was noticed concerning his feel of the helicopter's response while the capsule was being lifted out of the water. Pieces of the skirt were observed to tear away periodically during the return flight.

Upon return to the LSD an excellent capsule landing was effected on the receiving pallet and the rig was immediately pulled forward to allow capsule inspection and animal removal. Except for the fact that the impact skirt was torn away a few inches below the capsule, no capsule damage was apparent. The hatch was removed within one minute and the animal was heard making noises indicative of his being very much alive. The capsule was observed to contain a considerable amount of water and the water level was estimated at being about four inches below the lower edge of the hatch opening. The couch fittings were eneath the water in the capsule and although this hampered removal somewhat, the couch was removed in about 25 minutes. The water was then pumped out of the capsule, the instrument panel camera was removed, the hatch was replaced, and the capsule exterior was flushed thoroughly with fresh water.

The LSD proceeded to a position about 12 miles south of the Grand Bahama Auxiliary Air Force Base where the animal was transferred by helicopter to the GBI Medical Facility at approximately 0745 EST the following day. The LSD then proceeded to a position about 10 miles southeast of Cape Canaveral and the capsule was transferred by helicopter at 1700 EST to a

10.2.1 Retrieval Observations (Cont'd)

location near the Cape Canaveral Skid Strip. Further transport to Hangar S was accomplished by a LARC vehicle.

10.2.2 Performance of Recovery Aids

The recovery aids performed as intended. While the capsule was descending on main chute, UHF-DF contact was made by SARAH equipped aircraft in Stations 2 and 3 at ranges of about 97 and 135 nautical miles, respectively. capsule landing, UHF-DF contact was re-established on the SARAH beacon as the aircraft closed on the search area at ranges of from 50 to 20 miles depending on aircraft altitude and airborne receiver equipment. A WV-2 aircraft was located approximately 50 nautical miles southeast of the planned landing area (Figure 10.1-1) in order to evaluate UHF-DF receiver equipment compatible with both pulsed and CW transmissions. This aircraft received DF information from the UHF voice transmissions during capsule flight, and from both the pulsed and CW transmissions when the recovery beacons were in the recovery mode as the WV-2 flew toward the landing area.

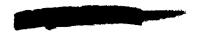
Destroyers in Stations 2, 5, and 6 received readable UHF capsule voice transmissions during flight.

Accurate radar chaff reports were received from AMR radar located at San Salvador.

The dye marker was streaming and visible to the recovery forces in the landing area until capsule retrieval. In addition, smoke was dropped by location aircraft as a visual aid.

The flashing light operated and continued to function until after the capsule was delivered to the recovery ship.

A Sofar report was received at 1 hour 20 minutes and confirmed the IP 709 landing point (Figure 10.1-1).



11.0 CAPSULE POSTFLIGHT INSPECTION

The postflight visual inspection of capsule no. 5 revealed that the capsule was generally in good condition, with the following major exceptions:

- l. The heat sink was missing, as was most of the fiber-glass impact skirt, which was torn all the way around. All of the stainless steel straps were broken at approximately the same section, i.e., near the lower spot-weld at the upper attachment. This can be seen in Figure 11.0-1. The fiber-glass shield beneath the large pressure bulkhead was pierced by five deep cuts (Fig. 11.0-2), which corresponded in spacing to the positions of the heat shield studs.
- 2. The large pressure bulkhead was punctured (Fig. 11.0-3) by two of the bolts on the terminal block immediately above the damaged area on the fiberglass shield. The larger of these holes was approximately 0.16 inch in diameter.



Figure 11.0-1. - Photograph showing broken retention straps and torn impact landing skirt.

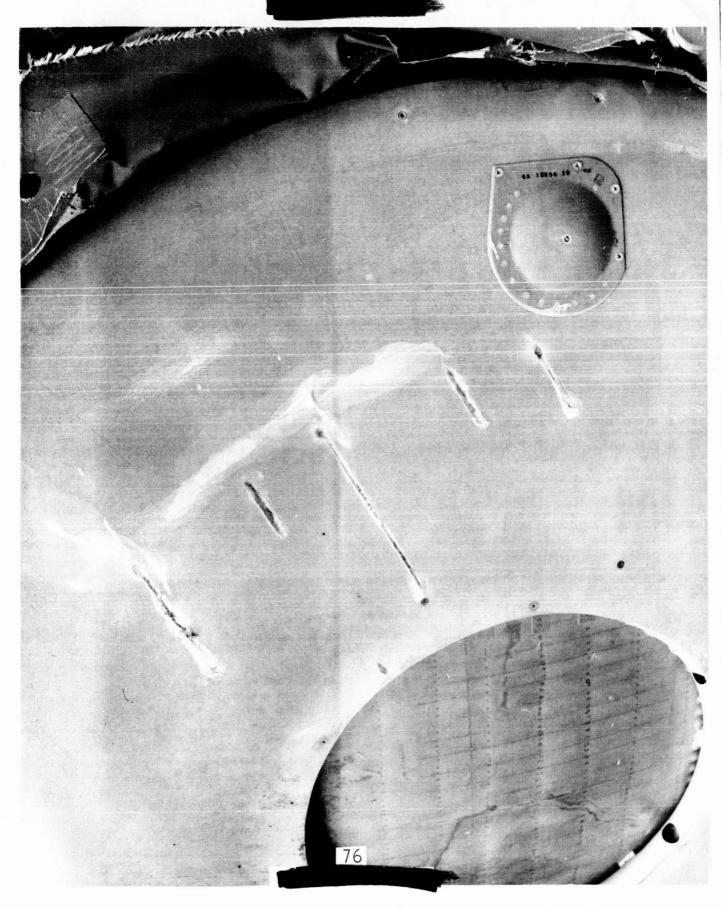


FIGURE 11.0-2 VIEW OF CUTS IN FIBERGLASS SHIELD
BENEATH LARGE PREESURE BULKHEAD



Figure 11.0-3.- View of punctures in large pressure bulkhead.

11.1 Structure

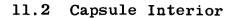
- 1. The J37 umbilical disconnect was still attached to the capsule. Both explosive cells had fired, but a shear pin still held, and the lock ring was still in place. The plug was wedged in its socket at an angle. The exposed wiring and socket were badly burned, as can be seen in Figure 11.1-1.
- 2. There was no evidence of excess heat near the RCS thrusters as had occurred in MR-1A. One of the aluminum feed pipes to the right yaw thrusters corroded through after the postflight inspection began, leaving a hole approximately 1/8 inch diameter in the wall of the tube.
- 3. The escape rocket blast eroded the phenolic adapter attachment ring at the base of the capsule. The left-hand window which was aligned with the rocket nozzle had been painted for this mission, but almost all of the paint had been ablated away, and its outer surface was badly scoured and was opaque. The right-hand window which was aligned between rocket nozzles was essentially clear.
- 4. The recovery compartment contained sooty deposits in areas near the cut-outs for the capsule-to-tower disconnects, which appeared to come from the escape rocket. Smoke was seen coming from the recovery compartment for a short time while the capsule was suspended by the LARC, and as it was being rotated about its Z axis. The source of this fire has not yet been determined, but is believed to be in the area of the flashing beacon light.
- 5. The crushable couch support blocks were damaged, (Fig. 11.1-2). This was apparently caused by the blocks rolling over onto the bulkhead stiffener either on installation or removal of the couch. These blocks are not attached to the capsule structure and it is believed that this damage did not result from the flight test.



Figure 11.1-1.- View of capsule-booster interface umbilical.



Figure 11.1-2.- View of damaged crushable couch support block.



- 1. When the capsule was returned to the hangar, it contained approximately five gallons of water. Considerable salt water corrosion was found. The recovery forces had reported that the capsule contained 18 inches of water when it was upright onboard ship. This corresponds to about 800 pounds of water.
 - 2. Switch positions were as follows:

Position
Off
Off
Normal
\mathbf{Off}
On
Off
Off
Off
Off
ASCS
Emergency
Reserve
\mathbf{R}/\mathbf{T}
Manual
UHF
Normal
Manual On
Continuous
Arm
Normal
Auto
Off

3. Indicator readings were as follows:

Indicator	Reading
Cabin Temperature Attitude Ind:	77°
Pitch	80°
Yaw	2400
Roll	90°
Accelerometer	+14.5 g
	-0.4 g
Interim Clock	978 sec. from launch
Coolant Quantity	15 percent



11.2 Capsule Interior (Cont'd)

Indicator	Reading
Auto Fuel	water 30 percent re- in maining
Manual Fuel	gauge 10 percent re- maining
	(tanks were empty of H_2O_2)

4. Control positions were as follows:

Control	Position	
Suit Temperature	Full CCW	
Cabin Temperature	Full CCW	
Emergency O ₂ Rate	Up	

5. Valve positions were as follows:

Condition
Tripped
Tripped
Interconnected

6. The periscope was in the extended position with the door locked open. This is a normal condition.

12.0 AMR SUPPORT, DATA COVERAGE, AND FILM REVIEW

12.1 AMR Support and Data Coverage

All Atlantic Missile Range (AMR) instrumentation committed to support the MR-2 mission was manned and operational. This instrumentation gave required coverage of the flight and resulted in good operational support and data coverage. The best information available at the time of this writing regarding instrumentation status and data coverage is presented below:

OPTICS

TYPE		STATION	NO. OF ITEMS COMMITTED	NO. OF ITEMS OBTAINED
Metric	1	(Canaveral)	24	24
Engineering Sequential	1	(Canaveral)	38	38
Engineering Sequential	3	(GBI)	2	2
Documentary	1	(Canaveral)	23	23

RADAR

All radars acquired signal and tracked with the exception of radar 3a.16 (MPS-25) located at Carter Cay. This radar was committed to skin track and was assigned to this test on an engineering trial basis only. Combined radar track for the test was obtained to approximately 13:24. Radar reduction personnel have indicated, however, that data recorded on the magnetic tape of the San Salvador FPS-16 (5.16) is not of good quality and may not provide usable trajectory data.

TELEMETRY

Excellent telemetry coverage was obtained from lift-off to landing. A combination of the Cape TLM-18 antenna and the GBI antennas feeding the subcable, provided real time telemetry to 10:20. Terminal telemetry coverage was provided by a telemetry aircraft in the landing area. This aircraft recorded good quality data to landing at 16:39 with adequate overlap of the Cape-GBI data. Information relative to telemetry reception by the telemetry ship in the landing area is not available at this writing.



12.1 AMR Support and Data Coverage (Cont'd)

AZUSA

The AZUSA operator's report indicated that good signal was obtained from 00:25 to 02:03 at which time a dropout occurred. Intermittent signal was then received from 02:48 to 06:00.

RANGE SAFETY

No Range Safety commands were transmitted during this test. A "Start Retrofire" command was activated at the Mercury Control Center and was transmitted by the FRW-2 transmitter at 04:41.

12.2 Film Review

12.2.1 Engineering Sequential

Photographic coverage was good, and all cameras requested were utilized. Although all cameras operated, some were facing the sun and yielded poor quality film due to over-exposure. Four items were 16mm films which showed capsule umbilical ejection and door closure, engine ignition, and lift-off to be normal. A 35mm camera on the Cape tracked all the way to abort and a few seconds thereafter. The IGOR at Patrick, using black and white film, tracked through abort and followed the booster for a few seconds thereafter.

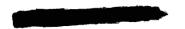
12.2.2 Onboard Film

The three onboard camera films were processed and were of satisfactory quality. The majority of the film will produce valuable information relative to the behavior of the chimpanzee, the instrument readings, capsule orientation relative to the earth, and appearance of the earth.



A preliminary evaluation of data and circumstances concerning the MR-2 flight test indicates the following:

- 1. Booster propellant consumption was higher than normal, causing a capsule abort as a result of propellant depletion before abort system disarming. Also, the associated high velocity caused an overshoot of the planned landing point.
- 2. Early in the flight, the inflow snorkel valve opened prematurely precluding the qualification of the environmental control system in its primary mode. The suit circuit of this system functioned properly in an emergency mode, however.
- 3. Following the capsule abort, all other capsule systems, with the exception of the impact bag, operated as designed for an abort.
- 4. Because of a series of compounding problems, including momentary loss of telemetry signal at abort and procedural problems, the exact sequence of events at the time of abort was not known in the Mercury Control Center until about one minute after the automatic abort.
- 5. At landing, the heat sink struck the lower part of the capsule and punctured the main pressure bulkhead. After landing, the heat sink separated from the capsule and sank. The capsule was recovered in a partially submerged condition. A large amount of water had entered the capsule.
 - 6. Recovery operations were satisfactory.
- 7. Post recovery information flow to the Control Center was not adequate.
- 8. The primate occupant of the capsule experienced ballistic space flight with no apparent ill effects, continuously performing his given task, in spite of high accelerations at abort and during re-entry.
 - 9. DOD support was good in all respects.

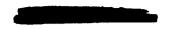


14.0 APPENDIX

14.1 Capsule Telemetry Instrumentation

COMMUTATED MEASUREMENTS

MEASUREMENT	INSTRUMENT RANGE
3 Volt DC Reference	3 v
0 Reference (ground)	
7 Volt AC Reference	7v
Body Temperature (Primate)	95–108 ⁰ F
Vibration (A Link)	10-2000 cps
Noise (B Link)	120-135 db
Suit Pressure	0-25 psia
Cabin Air Temperature	0-200°F
Suit Inlet Air Temperature	40-110°F
Y-axis Acceleration	+4g
X-axis Acceleration	+4g
Z-axis Acceleration	- 30g
Pitch Attitude	=140° to +160°
Roll Attitude	-130° to +180°
Yaw Attitude	-70° to 240°
Heat Shield Temperature - Edge (A Link)	-100° to 600°F
Heat Shield Temperature - Center (B	
Link - open)	$-100^{ m o}$ to $500^{ m o}{ m F}$
Outer Skin Temperature - (B Link fwd)	00 to 900°F
(A Link aft-open)	
Inner Skin Temperature (B Link)	-10 to +320°F
Main 250VA Inverter Temperature	•
(A Link)	-20 to 360 ⁰ F
Static Pressure	0-15 psia
Total Animal Response, Left-Hand	On-Off
Total Animal Response, Right-Hand	On-Off
Shock Occurrence	On-Off
Interim Clock (Units)	0-10 sec
Interim Clock (Tens)	0-100 sec
Interim Clock (Hundreds)	0-1000 sec
Interim Clock (Thousands)	0-10,000 sec
Time of Retro	On-Off
Nitrogen High Pressure - Automatic	0-2400 psia
Nitrogen High Pressure - Manual	0-2400 psia
AC Voltage Monitor (Fans Bus)	70-140 VAC
DC Current Monitor	0-35 amps
Tower Separation	On-Off
-	

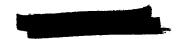


14.0 APPENDIX (Cont'd)

MEASUREMENT	INSTRUMENT RANGE
Capsule Separation	On-Off
Retro Attitude Command	On-Off
Retrorocket No. 1 Fire	On-Off
Retrorocket No.2 Fire	On-Off
Retrorocket No. 3 Fire	On-Off
Retrorocket Assy Jettison	On-Off
Drogue Chute Deploy	On-Off
Antenna Fairing Release	On-Off
Main Chute Deploy	On-Off
Main Chute Jettison	On-Off
Reserve Chute Deploy	On-Off
Duration of Blue Light (Chimp Psychomotor)	On-Off
Mayday	On-Off
Tower Escape Rocket Fire	On-Off
Standby Inverter - ON	On-Off
Standby Battery - ON	On-Off
Calibrate Signal	On-Off
High Pressure Jet (Pitch up)	On-Off
High Pressure Jet (Pitch down)	On-Off
Low Pressure Jet (Pitch up)	On-Off
Low Pressure Jet (Pitch down)	On-Off
High Pressure Jet (CW Roll)	On-Off
High Pressure Jet (CCW Roll)	On-Off
Periscope Retract Signal	On-Off
Low Pressure Jet (CW Roll)	On-Off
Low Pressure Jet (CCW Roll)	On-Off
High Pressure Jet (Yaw Left)	On-Off
High Pressure Jet (Yaw Right)	On-Off
Low Pressure Jet (Yaw Left)	On-Off
Low Pressure Jet (Yaw Right)	On-Off
Cabin Pressure	0-25 psia
DC Voltage Monitor	0-30 volts
Coolant Quantity	0-500 psia
0.05g Relay Activation	On-Off
Sync Pulse	•

CONTINUOUS MEASUREMENTS

Respiration Rate and Depth EKG EKG



14.2 Modifications to Capsule Instrumentation

Various modifications to the capsule instrumentation system were required and were accomplished by the NASA Launch Operations Unit to achieve mission objectives; to facilitate capsule testing during gantry operations; and to improve the signal quality, reliability, and, in some instances, eliminate ambiguities. The configuration of the capsule instrumentation at launch will be discussed in two groups; Biomedical and General.

14.2.1 Biomedical Instrumentation

Considerable problems were encountered during the prelaunch testing period. An electronic EKG simulator was designed, constructed, and used during the gantry operations to check out the medical instrumentation at the remote sites.

EKG Amplifiers - The EKG amplifiers received with the capsule were not satisfactory for flight. They were redesigned by NASA Launch Operations and delivered excellent EKG data during the entire flight. Output levels were greatly different (but readable) from amplifier to amplifier because adjustments could not be made on the gantry with the actual subject connected.

Respiration Rate and Depth Transducer and Amplifier-The respiration rate and depth transducer and amplifier delivered for flight wer not usable. These were redesigned by NASA Launch Operations and yielded excellent data from launch to splash.

Body Temperature Transducer - The transducer was calibrated during the entire flight.

Psychomotor Tester - The psychomotor tester operated properly during the prelaunch testing period and during the entire flight. Some modifications were made by MAC at the Cape to bring it into electrical and vibration specifications.

14.2.2 General System Modifications

The mixer amplifier was redesigned to provide increased voltage levels of the multiplexed composite FM signal to the tape recorder and to provide hardline signals to the blockhouse for continuous data monitoring during periods of RF silence. For system checks at remote sites, the hardline signals were used to modulate two auxiliary transmitters tuned to the capsule frequencies but located in the blockhouse. This technique proved to be most successfuland was instrumental in conserving the life of the capsule transmitters, which is limited to 50 hours and has an unknown tolerance for capsule temperatures.



14.2.2 General System Modifications (Cont'd)

The input circuitry to the 10.5 KC voltage controlled oscillators was modified to reduce the effective output voltage from the onboard commutators. A voltage divider was adjusted to confine the significant sidebands to +6 percent deviation, thereby allowing a guard-band of 1.5 percent deviation for oscillator center frequency drift.

The supply voltage to the three accelerometers was filtered and regulated to prevent noise on the 24v DC bus from appearing on the accelerometer outputs. Since the output impedance of the accelerometers is approximately 10,000 ohms, a 2 Microfarad condenser was connected across each accelerometer to reduce the AC impedance, thereby reducing the commutator sampling errors which come from talkback into the accelerometer. Satisfactory performance of the accelerometers was obtained during flight.

A despiking network was designed and installed on each of the programmer outputs to the cameras, to protect the programmer contacts from line transients.

A mirror and bracket assembly was designed and installed on the instrument panel to view the left-hand porthole by means of the instrument observer camera.

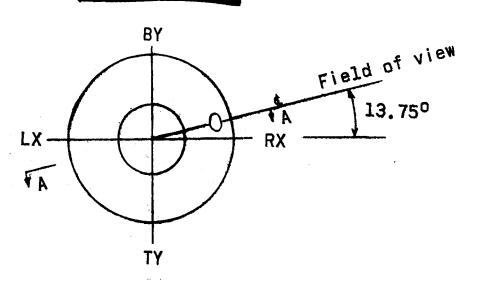
The radiation film packs used were of a new design. These have been removed and forwarded to the Naval Air Station at Pensacola, Florida.

The inner skin temperature pickup (Segment 21A) was removed and installed on the 250 VA main inverter. The inverter temperature was monitored continuously during the prelaunch countdown. The inverter temperature rose steadily to 192°F without any evidence of leveling off. Since there was still considerable time remaining until T-0, the count was recycled to T-120, the hatch was opened, and cold air was directed on the inverter until the temperature dropped below 110°F. The count was resumed and continued until launch. At launch, the inverter temperature was below 170°F. Figure 14.2-1 is a time history of these temperature readouts in the period preceding launch.

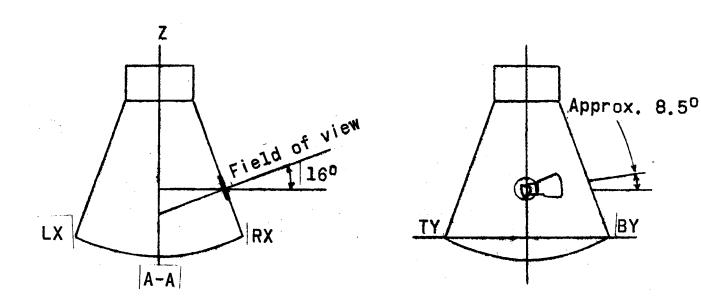
FIGURE 14.2-1 TIME HISTORY OF TEMPERATURE OF 250 VA INVERTER DURING COUNTDOWN

14.2.2 General System Modifications (Cont'd)

The periscope retract signal was modified to read out the closure of the periscope cover instead of monitoring the periscope motor current. Earth and Sky camera alignment data is presented in Figure 14.2-2.

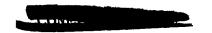


VIEW LOOKING TOWARD Z=0
VIEW "A"



ROTATED 15° CW WITH RESPECT TO VIEW "A" ROTATED 105° CW WITH RESPECT TO VIEW "A"

FIGURE 14.2-2 EART AND SKY CAMERA ALIGNMENT



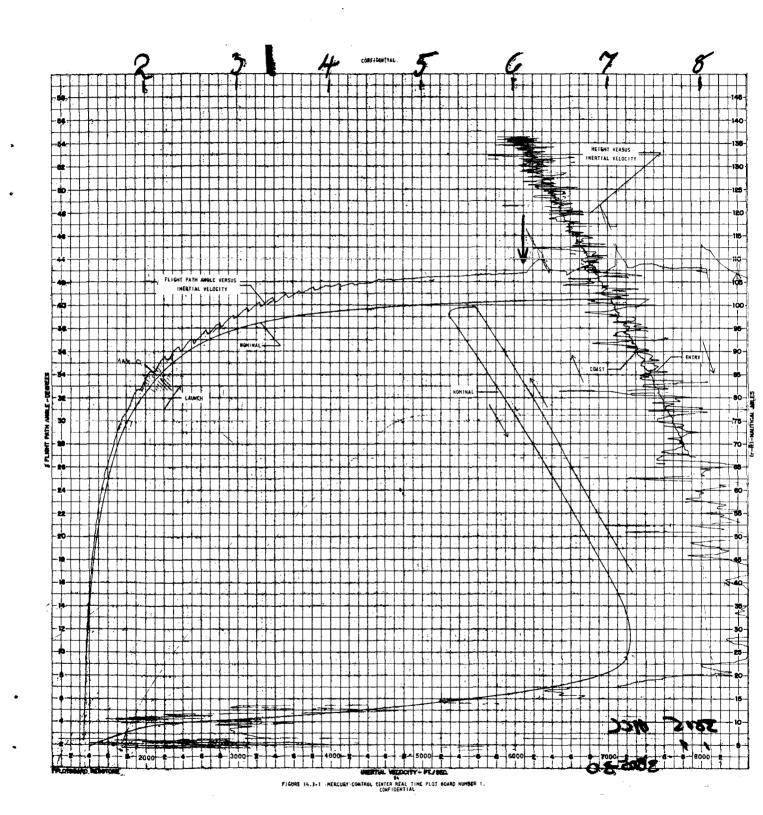
14.3 Computer and Data Flow System Operation

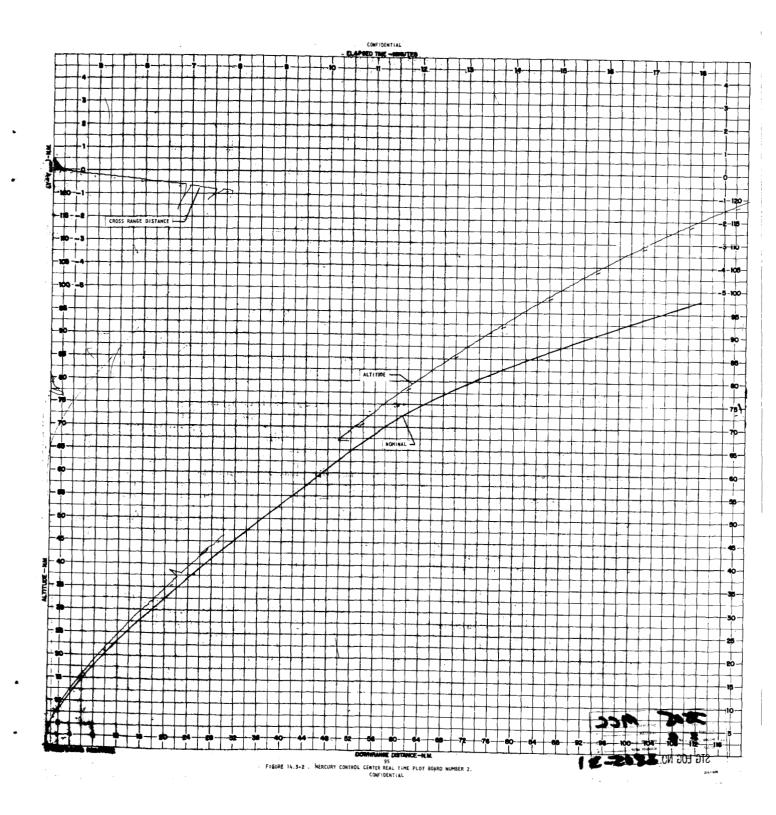
The Mercury Control Center plotboard and digital displays activated for this mission are based on computer programs written for Atlas missions. Because of this, they are relatively inefficient for use in Redstone missions since relatively complicated operational procedures are necessary for their proper operation.

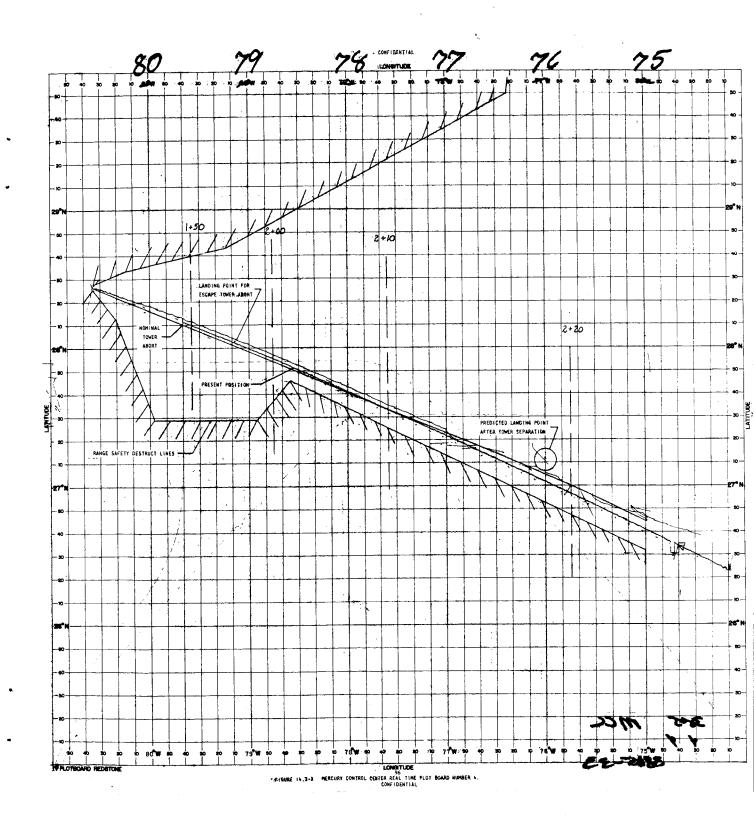
Direct copies of the Mercury Control Center plotboards are shown in Figures 14.3-1 to 14.3-3. These plotboards were activated by real time data from the AZUSA and the Cape FPS-16 radars. Position and velocity vectors were transmitted to the Goddard IBM 7090 Computer from the Range Safety Impact Prediction IBM 709 Computer. The launch computations were then made in real time and transmitted to the Mercury Control Center plotboards and digital displays. The plotboards and the quantities displayed are indicated in the following table:

PLOTBOARDS AND QUANTITIES DISPLAYED

FIGURE NO.	PLOTBOARD NO.	TIME	QUANTITY
14,3-1	la	Lift-off to manual closure of abort initiate override switch and closure of abort mode switch	Inertial flight-path angle (Y i) vs. inertial velocity (Vi)
	1b 🦏	Abort mode switch to loss of signal	Height above average spherical earth $(r-\overline{R})$ vs. inertial velocity (V)
14.3-2	2a	Lift-off to abort initiate switch	Crossrange distance (y)vs. downrange distance (d) Altitude (h) vs. downrange distance (d)
	2 b	Abort mode to loss of signal	Altitude (h) vs. down- range distance (d)







14.3 Computer and Data Flow System Operation (Cont'd)

FIGURE NO.	PLOTBOARD NO.	TIME	QUANTI TY
14.3.3	4a	Lift-off to tower separation	Impact point for immediate abort using escape tower. (Longitude and Latitude)
	4b	Tower separation to abort initiate switch	Impact point for retrofire near normal time. (Longitude and Latitude)
	4c	Abort mode to loss of signal	Present position and impact point as in 4b. (Longitude and Latitude)

The manual switches indicated in the above table were used as part of the operational procedures for Mercury-Redstone flights in order to adapt computer programs written for Atlas missions for use in Redstone missions.

These switches (except for the Abort-Hold-Orbit switch) are a part of the Flight Communicator's console and are used to confirm or reject event signals from capsule telemetry so that the input to the Goddard 7090 Computer can be controlled. Ordinarily, telemetry signals of any event are direct inputs to the computer. If the signal is found to be erroneous by the control center personnel the override switches at the Capsule Communicator's Console are used to correct the input. The computer can always correct its computations to provide the correct displays to the control center until the time that the Abort-Hold-Orbit switch (located in the data selection room of the control center) is changed from Hold to either Abort or Orbit at the direction of the Flight Dynamics Officer. Ordinarily this is done for an Atlas mission after the GO-NO-GO decision is made. Once the change is made to Abort or Orbit, however, the computer is not presently capable of re-entering the launch (Hold) mode. fore it is very important to establish if an abort truly has occurred before changing the computer mode with the Abort-Hold-Orbit switch.

14.3 Computer and Data Flow System Operation (Cont'd)

The computer logic utilizes telemetry events signals and manual overrides of these signal to control the output to the Mercury Control Center. The signals used for the Redstone mission and the signal source are indicated below in the order that they were normally expected to occur:

	NT AND ORDER OCCURRENCE	SOURCE	TIME
1.	Lift-off	Manual override switch	At lift-off
2.	Tower separation	Direct telemetry into computer	
3.	Abort Initiate	Manual override switch	At engine cutoff
4.	Posigrade firing	Manual override switch	At capsule separation
5.	Capsule separation	Direct telemetry into computer	
6.	Abort-Hold-Orbit Switch to abort mode	Manual 3 position switch	After capsule separation
7.	Retrofire	Direct telemetry into computer	
8.	Escape rocket fire	Direct telemetry into computer	

The lift-off manual override and the posigrade manual override switch were planned to be used in this mission since these signals were not yet available from capsule telemetry or other sources.

The abort initiate override switch was planned to be used in this mission as an engine cutoff signal to replace the normal SECO signal received in Atlas missions. A cutoff signal was not available to the computer from Redstone telemetry, and a SECO override switch had not yet been provided in the control center.



In the actual flight telemetry was lost at burnout when the abort actually occurred, and as a result most of the telemetry events were transmitted erroneously to the computer. The telemetry event signal indicating escape tower separation was included in this transmission and caused the computer to predict impact points assuming firing of the retrorockets rather than firing of the escape tower, causing the calculated impact point to be short of the actual.

Since the telemetry signals indicating abort initiate and capsule separation were also received, the computing program entered and completed the GO-NO-GO computations, subsequently transferring program control from the launch phase to the hold phase. The Redstone computing program did not contain necessary logic to enable transfers back to the launch phase from the hold phase and consequently was locked in the hold phase until the Abort-Hold-Orbit witch was placed in the abort position. Program logic to accompoish this transfer back to the launch phase had not yet been added to the Redstone program.

For this specific type of abort, an abort with the escape tower during which the telemetry events indicate tower separation, the tower separation event must be manually overridden to prevent erroneous computation of the impact point. For the MR-2 mission this manual override should have occurred at the time tower separation appeared or during the nine second period between the appearance of the signal and entry of the hold phase by the computing program. The override was actually set seven seconds after the abort switch or approximately 38 seconds after the appearance of the tower separation telemetry.

It should be emphasized that this same situation can also occur with the Mercury-Atlas computing program.

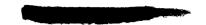
The event times are noted below:

EVENT	TIME FROM RANGE ZERO
Actual Abort Initiate (Telemetry)	02:18
Escape Rocket Fire (Telemetry)	02:18
Tower separation (erroneous event	
from telemetry at loss of signal)	02:21.17
Abort-Hold-Orbit switch set to abort	
manually	02:52.73
Tower separation manually overridden	
to no event	02:59.54

14.3 Computer and Data Flow System Operation (Cont'd)

In addition to the loss of telemetry when the escape rocket fired, the sequence of events in the mission were further confused by a loss of AZUSA data five seconds before booster fuel depletion. The data source was then switched to the Cape FPS-16 radar and this radar lost lock when the escape rocket fired and did not regain lock until eight seconds later. The effects of the complete dropout of data immediately at engine burnout can be seen in Figures 14.3-1 to 14.3-3. In addition, the Goddard computer used these noisy data to compute an erroneous burn out velocity of 9.220 feet per second.

Although the many simultaneously occurring events resulted in a poor presentation to the control center personnel, the computing system performed satisfactorily in that it did what it was told to do. It is evident, however, that in order to insure adequate presentations to the Mercury Control Center personnel for future missions, modifications should be made to the operational procedures and to the computer program for specific Redstone use.



FLIGHT EVALUATION TEAM

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In addition, W. J. Kapryan assisted in editing the material concerning capsule measurements and systems performance.

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